



Evaluation of Monopotassium Phosphate-Based Starter Fertilizer Solutions for Tomato and Pepper Production in Florida 96-07

George J. Hochmuth¹

Abstract

Planting tomato and pepper slightly earlier resulted in greater yields than slightly later-than-optimum planting date. Mulch color, white or black, had little effect on tomato early or total yield, but pepper early and total yields were improved with black mulch. Starter fertilizer had little effect on tomato yields but did improve pepper yields. Early and total-season pepper yields were greatest with ammoniated monopotassium phosphate solution, ammonium polyphosphate, or mixtures of these two fertilizers.

Materials and Methods

Experiments were conducted in spring 1996 with starter solutions formulated from monopotassium phosphate to follow-up on results from spring 1995. These studies were conducted at the Horticultural Research Unit of the University of Florida at Gainesville FL. The soil used was Arendondo fine sand with a water pH of 6.5 and was medium-low in K and very high in P (Mechlich-1 extractant).

Two plantings of each crop, tomato and pepper, were used to evaluate crop responses to starter fertilizers for crops established under slightly earlier and slightly later than typical for north central Florida planting window, which is March 15. The first planting was made on February 28 and the second planting was made on March 25. March was extremely cold; the crops had to be covered with frost protection covers on six occasions. In addition, March was wet with more than 10 inches of rain. Some minor wind and frost damage occurred on the first planting. April also was cool and frost protection was used twice, once as late as April 17. Even though the second planting was projected to experience warm temperatures, it was, however, exposed to cooler-than-normal temperatures.

Tomato and pepper were planted on both black and white-on-black polyethylene mulches. The two mulches were used to enhance chances of having variable soil temperatures, cooler under the white-on-black mulch.

Soil was plowed and disked two weeks before tomato and pepper beds were made. Beds for tomato and pepper were prepared on four-foot centers. A false-bed was made

¹ George J. Hochmuth, Professor, Horticultural Sciences Department, University of Florida/IFAS, Gainesville FL 32611-0690

into which was banded ammonium nitrate at 100 lbs/acre to supply 33 lbs N per acre. The soil and ammonium nitrate were thoroughly mixed by rototilling. The beds were then fumigated with methyl bromide at 300 lbs/acre, broadcast rate, pressed, and covered with polyethylene mulch, either white-on-black or black, depending on mulch treatment. Drip irrigation tubing, Netafim Typhoon (0.34 gal per hour per emitter at 10 psi on 12-inch spacing) was placed three inches off bed center and one inch deep.

Tomato (cv Agriset) and pepper cv. Camelot X3R) were obtained from a commercial transplant production company and were five week old at transplanting. Tomato transplants were planted in a single row in the center of each bed with 18 inches between plants. Pepper plants were planted in two rows on each bed with 12 inches between rows and 12 inches between plants in a row. Plots contained 17 tomato plants and 40 pepper plants.

Starter fertilizer treatments were:

1. MKP (liquid monopotassium phosphate 0-10-7 (N-P₂O₅-K₂O))
2. AMKP (ammoniated monopotassium phosphate (3-22-15))
3. AMKP/APP (mixture of one part AMKP and one part ammonium polyphosphate (10-34-0))
4. APP (ammonium polyphosphate, 10-34-0)
5. MKP/MAP (mixture of one part MKP and two parts MAP, monoammonium phosphate)
6. TSP (triple superphosphate)
7. Check (no starter fertilizer)

Starter fertilizer solutions were formulated to provide phosphorus at 10 lbs P₂O₅ per acre. Solutions were applied at 250 mls per plant at transplanting by pouring solution by hand into plant hole. The TSP starter fertilizer was broadcast in the bed and incorporated with the ammonium nitrate.

Irrigation was done with drip irrigation to maintain a tensiometer at -8 to -12 cb at the six-inch soil depth. On average, this resulted in the application of 600 gal water per acre per day early in the growth period to 7000 gal per acre per day at near first harvest for the crop planted on 4-foot centers. On a weekly basis, N and K were injected through the irrigation system starting at the second week after planting. Mixtures of ammonium nitrate and potassium nitrate were used. Total N injected was 145 lbs N per acre and total K was 225 lbs K₂O per acre. On five occasions (week, 3, 5, 7, 9, and 11) magnesium sulfate was injected at 5 lbs Mg per acre.

Tomato plants were staked and tied, and pruning was done once, three weeks after planting, to remove two lower branches. Tomatoes and peppers were sprayed on a

regular frequency with labeled insecticides and fungicides. Bacterial spot disease was a minor problem on the first tomato planting enhanced by constant rainfall and wind. The second tomato crop and both pepper crops were problem-free. No foliar nutrient sprays were used.

On two occasions, four and six weeks after planting, on tomato and two pepper plants from each plot were cut at the soil line, dried, and weighed. Dry weight data were used to determine starter solution effects on early plant growth.

Tomatoes were harvested three times for each planting (29 May and 5 and 19 June for first planting and 5, 13, and 25 June for the second planting). Pepper was harvested on 23 May and 4 and 19 June for the first planting and on 4 and 19 June for the second planting. Data were analyzed by analysis of variance to determine significance of main effects and interactions. Comparisons were made among starter fertilizer means with the least significant difference method when the main effect of fertilizer treatment was significant.

Results – Tomato

Planting date. Yields (early and total) from the early planting were greater than for the second planting (Tables 1, 2, and 3). This result was similar to results from last season.

Mulch. Mulch color had little effect on tomato yields in spring 1996 (Tables 1, 2 and 3). Previous studies showed that early yields were higher with black mulch but total-season yields were higher with white mulch. Soil under black mulch averaged 83°F while soil under the white mulch averaged 80°F for the period 17 Apr through 20 Jun.

Starter fertilizer. Starter fertilizer had little effect on tomato yields in the spring of 1996 (Fig 1, Tables 1, 2, and 3). These results are different from 1995 when ammoniated MKP starters resulted in greater tomato yields. It is possible that frost damage in April removed any early differences in plant growth due to starter fertilizer. AMKP solutions were particularly effective in promoting plant growth (Table 7) but increased growth did not lead to increased yield.

Results – Pepper

Planting date. Total season pepper yields were greater for the early planting (Tables 4, 5, and 6). Most fruit size grades were affected by planting date with slightly greater yields with the earlier planting. These results were similar to the 1995 study.

Mulch color. Pepper yield was significantly affected by mulch color. Early yield was greater with black mulch similar to the 1995 crop response. However, in 1996, total-season yield also was enhanced with black mulch unlike 1995 when total-season yield

was better with white mulch. Warmer soil temperatures with black mulch led to enhanced growth.

Starter fertilizer. Starter fertilizer treatments affected pepper yield significantly in 1996 (Fig 2, Tables 4, 5, and 6). Most liquid starter solutions provided for better yields than with triple superphosphate or with no starter fertilizer. Greatest benefit for total-season yield was with ammoniated MKP (AMKP), APP alone, mixture of AMKP/APP, and mixture of MKP and MAP. Similar results were obtained for early pepper yield. Yields of extra large fruits were best with AMKP or APP, or mixture of AMKP and APP. As in 1995, the ammoniated MKP material resulted in highest yields. These benefits were due to enhanced early plant growth due to starter solutions (Table 7).

Fig 1 - Tomato Yield

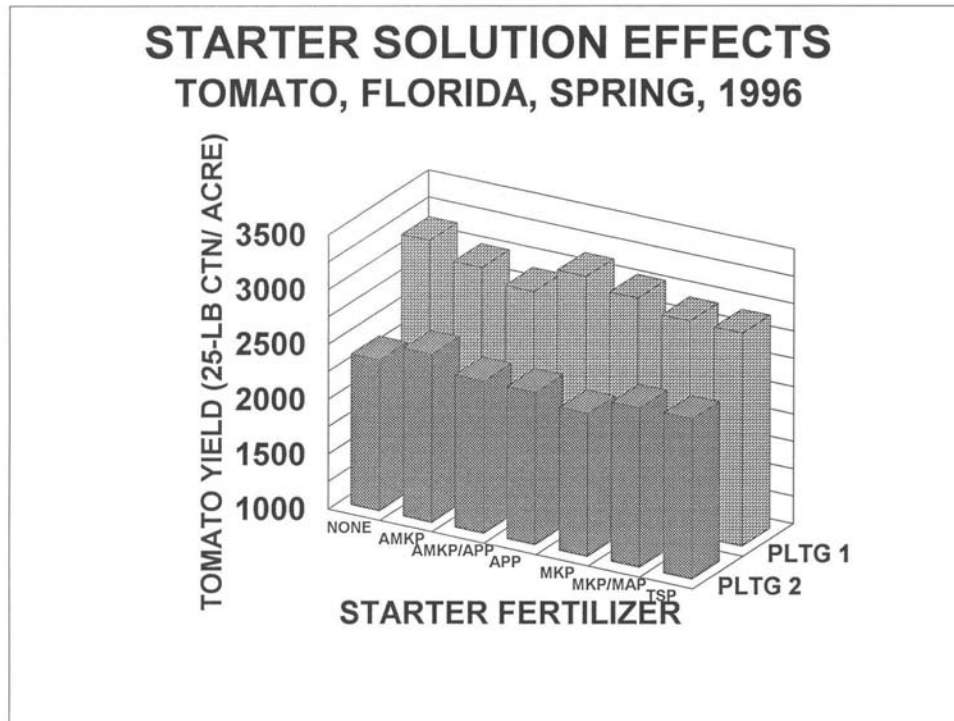


Fig 2 - Pepper Yield

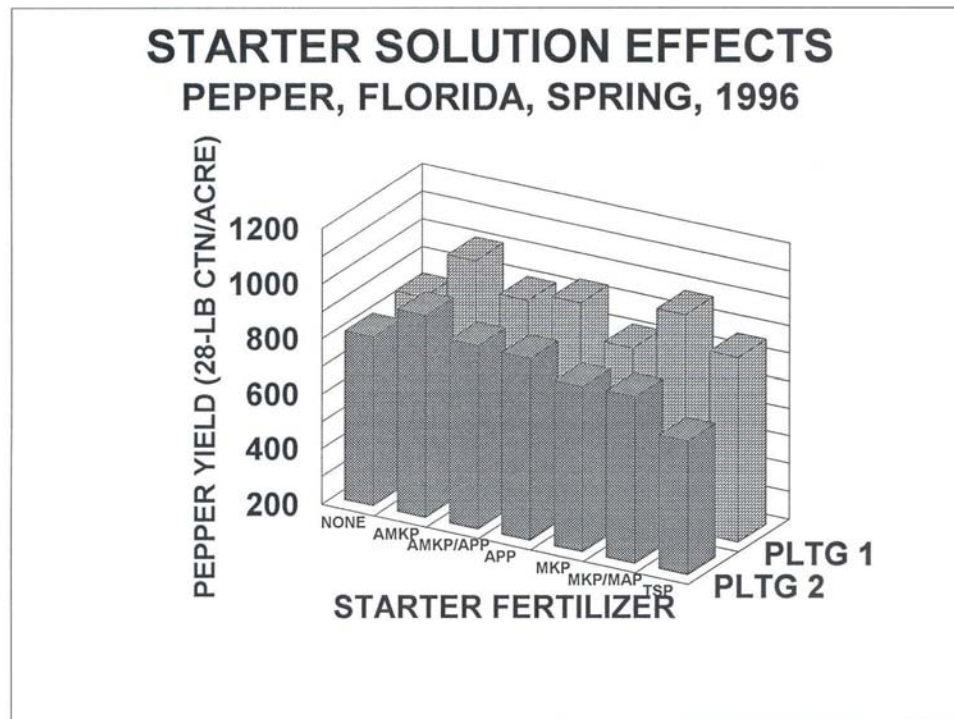


Table 1. Effects of mulch and starter fertilizer on yield and fruit grade of tomato in a first planting, Gainesville FL, spring 1996.

Mulch	Starter Fertilizer ^z	Yield (25-lb carton/acre)					Avg. Fruit Wt. (lb)
		Medium	Large	Ex. Large	Total Mkt.	Cull	
----- First Harvest -----							
Black	None	22	83	191	286	7	0.52
	AMKP	55	75	225	355	13	0.50
	AMKP/ APP	40	78	245	363	22	0.53
	APP	32	62	182	275	18	0.54
	MKP	13	57	202	272	3	0.70
	MKP/MAP	55	95	201	351	16	0.49
	TSP	30	74	228	333	12	0.56
White	None	18	36	232	286	11	0.59
	AMKP	13	58	238	309	11	0.56
	AMKP/ APP	35	59	193	287	17	0.53
	APP	36	95	247	378	12	0.51
	MKP	20	96	288	405	17	0.57
	MKP/MAP	10	67	152	229	10	0.55
	TSP	25	74	220	319	15	0.54
----- Season (3 harvests) -----							
Black	None	1172	1015	1011	3198	200	0.46
	AMKP	1109	963	906	2979	205	0.46
	AMKP/ APP	1169	835	893	2897	145	0.46
	APP	1149	984	963	3096	169	0.48
	MKP	957	1013	954	2925	116	0.50
	MKP/MAP	1145	1029	998	3172	154	0.46
	TSP	892	813	1105	2811	193	0.47
White	None	993	911	1228	3132	144	0.48
	AMKP	1009	948	1102	3059	153	0.51
	AMKP/ APP	1060	905	943	2909	139	0.44
	APP	1036	1123	1034	3193	148	0.48
	MKP	1007	978	1189	3175	103	0.47
	MKP/MAP	870	813	1030	2714	106	0.46
	TSP	1050	1016	996	3062	168	0.45

^z Starter fertilizers were AMKP (ammoniated monopotassium phosphate), AMKP/APP (a 1:1 mixture of AMKP and ammoniated polyphosphate), APP (ammoniated polyphosphate), MKP (monopotassium phosphate), MKP/MAP (a 1:2 mixture of MKP and monoammonium phosphate), and TSP (triple superphosphate).

Table 2. Effects of mulch and starter fertilizer on yield and fruit grade of tomato in a second planting, Gainesville FL, spring 1996.

Mulch	Starter Fertilizer ^z	Yield (25-lb carton/acre)					Avg. Fruit Wt. (lb)
		Medium	Large	Ex. Large	Total Mkt.	Cull	
----- First Harvest -----							
Black	None	3	20	110	135	4	0.69
	AMKP	4	18	163	1847	3	0.65
	AMKP/ APP	1	27	258	286	11	0.69
	APP	8	15	136	159	1	0.67
	MKP	3	19	174	196	6	0.67
	MKP/MAP	0	14	102	116	4	0.69
	TSP	8	22	175	206	11	0.68
White	None	0	15	128	143	20	0.64
	AMKP	4	26	140	170	4	0.67
	AMKP/ APP	3	6	65	75	2	0.53
	APP	6	26	160	188	12	0.70
	MKP	4	23	170	197	7	0.67
	MKP/MAP	11	18	90	119	2	0.59
	TSP	5	13	81	100	4	0.54
----- Season (3 harvests) -----							
Black	None	877	791	756	2425	340	0.50
	AMKP	844	845	876	2566	352	0.50
	AMKP/ APP	795	752	934	2382	473	0.48
	APP	762	934	972	2668	205	0.52
	MKP	800	799	8674	2465	344	0.49
	MKP/MAP	800	874	916	2765	394	0.51
	TSP	864	798	864	2528	390	0.50
White	None	935	711	664	2311	207	0.49
	AMKP	948	749	781	2311	207	0.49
	AMKP/ APP	855	788	747	2390	424	0.44
	APP	726	709	665	2101	479	0.49
	MKP	739	740	650	2129	487	0.48
	MKP/MAP	870	616	647	2134	482	0.45
	TSP	835	844	700	2379	566	0.44

^z Starter fertilizers were AMKP (ammoniated monopotassium phosphate), AMKP/ APP (a 1:1 mixture of AMKP and ammoniated polyphosphate), APP (ammoniated polyphosphate), MKP (monopotassium phosphate), MKP/MAP (a 1:2 mixture of MKP and monoammonium phosphate), and TSP (triple superphosphate).

Table 3. Main effects of planting, mulch, and starter fertilizer on tomato yield and fruit grade, Gainesville FL, spring 1996.

Treatment	Yield (25-lb carton/acre)					Avg. Fruit Wt (lbs)
	Medium	Large	Ex Large	Total Mkt.	Cull	
----- First Harvest -----						
Planting 1	29	72	218	318	13	0.55
Planting 2	4	19	139	162	6	0.65
Prob >F	0.0001	0.0001	0.0001	0.0001	0.0010	0.0001
Black Mulch	20	47	185	252	9	0.61
White Mulch	14	44	171	229	10	0.58
Prob >F	0.0356	0.5647	0.4201	0.2835	0.6308	0.1606
No starter ^z	11	39	165	214	11	0.61
AMKP	19	44	191	254	8	0.60
AMKP/ APP	20	42	191	253	13	0.57
APP	20	49	180	250	10	0.60
MKP	10	49	209	267	8	0.65
MKP/MAP	19	48	147	204	8	0.58
TSP	17	46	176	239	11	0.58
Prob >F	0.2403	0.9463	0.4017	0.6781	0.7718	0.3324
LSD (0.05)	N/A	N/A	N/A	N/A	N/A	N/A
----- Season (3 harvests) -----						
Planting 1	1044	953	1025	3023	153	0.46
Planting 2	845	782	782	2409	398	0.48
Prob >F	0.0001	0.0001	0.0001	0.0001	0.0001	0.0181
Black Mulch	965	889	922	2777	262	0.47
White Mulch	923	847	884	2654	289	0.46
Prob >F	0.1793	0.1596	0.2905	0.0948	0.2977	0.1996
No starter ^z	994	876	915	2766	223	0.47
AMKP	977	820	916	2770	284	0.49
AMKP/APP	970	937	854	2644	295	0.45
APP	918	857	908	2764	250	0.48
MKP	875	882	915	2673	262	0.49
MKP/MAP	965	833	898	2696	284	0.47
TSP	910	867	917	2695	329	0.47
Prob >F	0.3416	0.4769	0.9684	0.9429	0.3626	0.2998
LSD (0.05)	N/A	N/A	N/A	N/A	N/A	N/A

^z Starter fertilizers were AMKP (ammoniated monopotassium phosphate), AMKP/APP (a 1:1 mixture of AMKP and ammoniated polyphosphate), APP (ammoniated polyphosphate), MKP (monopotassium phosphate), MKP/MAP (a 1:2 mixture of MKP and monoammonium phosphate), and TSP (triple superphosphate).

Table 4. Effects of mulch and starter fertilizer on yield and fruit grade of pepper in a first planting, Gainesville FL, spring 1996.

Mulch	Starter Fertilizer ^z	Yield (25-lb carton/acre)					Avg. Fruit Wt. (lb)
		Medium	Large	Ex. Large	Total Mkt.	Cull	
----- First Harvest -----							
Black	None	0	2	185	187	18	0.47
	AMKP	0	3	227	230	21	0.45
	AMKP/ APP	0	7	287	295	19	0.45
	APP	0	4	300	304	12	0.46
	MKP	0	4	202	205	19	0.44
	MKP/MAP	0	1	271	272	8	0.46
	TSP	0	5	180	184	17	0.43
White	None	0	3	72	75	10	0.45
	AMKP	0	5	96	102	20	0.44
	AMKP/ APP	0	5	109	114	13	0.48
	APP	0	1	150	151	15	0.46
	MKP	0	0	64	64	18	0.41
	MKP/MAP	0	4	80	84	11	0.42
	TSP	0	1	73	74	12	0.46
----- Season (3 harvests) -----							
Black	None	114	374	384	873	38	0.37
	AMKP	215	416	482	1114	43	0.37
	AMKP/ APP	149	342	529	1019	70	0.42
	APP	158	313	431	902	41	0.38
	MKP	149	386	478	1013	48	0.38
	MKP/MAP	130	393	362	886	43	0.38
	TSP	136	326	368	830	35	0.36
White	None	105	297	348	751	65	0.36
	AMKP	103	278	370	708	53	0.40
	AMKP/ APP	68	255	383	813	31	0.38
	APP	93	291	428	751	57	0.39
	MKP	87	204	289	580	66	0.36
	MKP/MAP	135	243	338	716	79	0.36
	TSP	75	167	291	533	42	0.36
^z Starter fertilizers were AMKP (ammoniated monopotassium phosphate), AMKP/ APP (a 1:1 mixture of AMKP and ammoniated polyphosphate), APP (ammoniated polyphosphate), MKP (monopotassium phosphate), MKP/MAP (a 1:2 mixture of MKP and monoammonium phosphate), and TSP (triple superphosphate).							

Table 5. Effects of mulch and starter fertilizer on yield and fruit grade of pepper in a second planting, Gainesville FL, spring 1996.

Mulch	Starter Fertilizer ^z	Yield (25-lb carton/acre)					Avg. Fruit Wt. (lb)
		Medium	Large	Ex. Large	Total Mkt.	Cull	
----- First Harvest -----							
Black	None	6	142	114	263	1	0.35
	AMKP	6	134	185	325	1	0.38
	AMKP/ APP	9	127	228	364	1	0.41
	APP	0	79	202	281	0	0.39
	MKP	7	128	174	310	2	0.37
	MKP/MAP	3	152	148	304	5	0.35
	TSP	8	123	144	275	3	0.36
White	None	7	100	89	196	1	0.32
	AMKP	0	77	107	184	3	0.37
	AMKP/ APP	3	85	104	193	5	0.35
	APP	5	101	119	225	0	0.36
	MKP	1	47	83	132	1	0.35
	MKP/MAP	1	65	82	149	0	0.36
	TSP	1	58	88	148	3	0.35
----- Season (2 harvests) -----							
Black	None	187	411	357	955	75	0.38
	AMKP	259	473	406	1139	106	0.35
	AMKP/ APP	180	328	429	937	109	0.36
	APP	192	405	526	1123	89	0.37
	MKP	178	350	392	920	88	0.43
	MKP/MAP	214	395	538	1146	82	0.37
	TSP	209	438	367	1114	90	0.35
White	None	156	299	267	723	64	0.37
	AMKP	165	388	332	885	70	0.36
	AMKP/ APP	203	367	311	881	93	0.37
	APP	179	317	264	760	93	0.35
	MKP	165	310	239	715	86	0.33
	MKP/MAP	152	369	294	816	90	0.36
	TSP	153	325	240	719	72	0.37

^z Starter fertilizers were AMKP (ammoniated monopotassium phosphate), AMKP/ APP (a 1:1 mixture of AMKP and ammoniated polyphosphate), APP (ammoniated polyphosphate), MKP (monopotassium phosphate), MKP/MAP (a 1:2 mixture of MKP and monoammonium phosphate), and TSP (triple superphosphate).

Table 6. Main effects of planting, mulch, and starter fertilizer on pepper yield and fruit grade, Gainesville FL, spring 1996.

Treatment	Yield (25-lb carton/acre)					Avg. Fruit Wt (lbs)
	Medium	Large	Ex Large	Total Mkt.	Cull	
----- First Harvest -----						
Planting 1	0	3	164	167	15	0.44
Planting 2	4	101	134	239	2	0.36
Prob >F	0.0001	0.0001	0.0123	0.0001	0.0001	0.0001
Black Mulch	3	65	203	272	9	0.41
White Mulch	1	40	94	135	8	0.40
Prob >F	0.0725	0.0002	0.0001	0.0001	0.5795	0.0552
No starter ^z	3	62	115	180	8	0.40
AMKP	1	55	154	211	11	0.40
AMKP/APP	3	56	182	241	10	0.42
APP	1	46	192	241	7	0.42
MKP	2	45	130	178	10	0.39
MKP/MAP	1	55	145	202	6	0.40
TSP	2	47	121	170	9	0.40
Prob >F	0.7061	0.7831	0.0034	0.0498	0.7040	0.1442
LSD (0.05)	N/A	N/A	60	70	N/A	N/A
----- Season (all harvests) -----						
Planting 1	185	370	355	910	86	0.36
Planting 2	123	306	392	821	51	0.38
Prob >F	0.0001	0.0001	0.1302	0.0092	0.0001	0.0001
Black Mulch	177	382	432	991	69	0.31
White Mulch	132	294	314	740	69	0.31
Prob >F	0.0001	0.0001	0.0001	0.0001	0.9919	0.2235
No starter ^z	140	346	339	825	61	0.31
AMKP	185	389	397	973	68	0.30
AMKP/APP	150	323	413	887	76	0.31
APP	155	332	412	900	70	0.30
MKP	144	313	349	807	72	0.33
MKP/MAP	158	350	383	892	74	0.31
TSP	143	314	316	774	59	0.30
Prob >F	0.1782	0.1272	0.2095	0.0407	0.5231	0.8931
LSD (0.05)	N/A	N/A	N/A	N/A	N/A	N/A

^z Starter fertilizers were AMKP (ammoniated monopotassium phosphate), AMKP/APP (a 1:1 mixture of AMKP and ammoniated polyphosphate), APP (ammoniated polyphosphate), MKP (monopotassium phosphate), MKP/MAP (a 1:2 mixture of MKP and monoammonium phosphate), and TSP (triple superphosphate).

Table 7. Main effects of planting, mulch, and starter fertilizer on tomato and pepper plant growth, Gainesville FL, spring 1996.

Treatment	Pepper (gr/2 plants)		Tomato (gr/plant)	
	First Sample	Second Sample	First Sample	Second Sample
Planting 1	6.5	27.6	15.1	77.3
Planting 2	9.7	56.9	15.4	90.1
Prob >F	**	**	NS	**
Black Mulch	9.4	46.3	14.9	84.5
White Mulch	6.7	38.3	15.7	82.8
Prob >F	**	**	NS	NS
No starter ^z	6.2	35.3	13.2	81.9
AMKP	9.2	45.8	18.0	92.3
AMKP/APP	9.3	46.5	17.2	88.7
APP	8.5	43.6	15.8	86.9
MKP	7.4	40.5	12.7	76.4
MKP/MAP	8.2	44.7	14.6	74.2
TSP	7.6	39.7	15.6	85.2
LSD (0.05)	1.8	1.8	NS	10.5
^z Starter fertilizers were AMKP (ammoniated monopotassium phosphate), AMKP/APP (a 1:1 mixture of AMKP and ammoniated polyphosphate), APP (ammoniated polyphosphate), MKP (monopotassium phosphate), MKP/MAP (a 1:2 mixture of MKP and monoammonium phosphate), and TSP (triple superphosphate).				