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Monopotassium Phosphate as a Phosphorus and Potassium Source for Greenhouse-Winter-Grown Cucumber and Muskmelon[1]

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ABSTRACT

Glasshouse experiments were conducted at the Newe Ya'ar Research Center in the winter seasons of 1992/93 and 1993/94 to examine a phosphorus/potassium (PK) fertilizer for cucurbit crops. Monopotassium phosphate [(MKP), KH_2PO_4] was found to be very effective as a P and K source for cucumber (*Cucumis sativus* L.) and muskmelon (*Cucumis melo* L.) plants grown in soilless container conditions. The efficiency of MKP was essentially not different from that of the combination of phosphoric acid (H_3PO_4) and potassium chloride (KCl) which is widely used in the commercial production of vegetables. Appropriate fertilization of cucumbers with MKP in 1992/93 affected late-season yield more than early-season yield. Deficiency of P and K in Gala muskmelon inhibited vegetative growth and decreased yield. The reduced yield resulted from both less fruit-setting and smaller fruit size. The MKP rates required by cucumber plants in 1993/94 depended primarily on

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growth medium composition. Generally, plants grown in inert tuff (volcanic gravel) and sandy media responded more significantly to MKP than did those grown in media rich in organic matter. There are at least three reasons for preferring the use of MKP, first it is much safer to handle than is H_3PO_4, second it is highly soluble and can be easily incorporated in fertigation systems, and third it has a high PK content.

INTRODUCTION

Cucumber and muskmelon are chilling-sensitive crops that can be grown in the winter only under low-temperature-protected conditions (Lester, 1990; Wright and Simon, 1973). Winter-grown cucumbers are very popular in Israel and are generally transplanted into soil under unheated plastic tunnels. Recently, because of pathogenic contamination, there has been an increasing trend to grow cucumbers and melons in containers and soilless media. Mineral nutrition for soil-grown cucurbits is well documented (Ingestad, 1973; Sanchez et al., 1990; Tyler and Lorenz, 1964; Ward, 1967), but not much information is available for growth under soilless media and with restricted root zones. While most soil conditions provide a flexible schedule of irrigation and fertilization, soilless media, especially in restricted-size containers, require short intervals between irrigations and a continuous supply of nutrients. In soilless media, and particularly, in organic matter-free media, a complete nutritional solution has to be used (Bartkowski, 1985; Jonsson and Ottosson, 1978). Cucumber and muskmelon plants grown under soilless conditions require 100-500 ppm of each of the macroelement—nitrogen (N), P, and K—in the nutrient solution for optimal growth and development (Massrawa et al., 1984; Nerson et al., 1987; Ward, 1967). Nutrient solutions in which N or P concentrations are as low as 20 ppm impose nutritional stress in muskmelon (Nerson et al., 1987, 1988). The most common P and K fertilizers applied in the field and to horticultural crops are superphosphate, H_3PO_4, and KCl. Fertilizer MKP is an efficient source of P and K, however, its commercial use is limited to research (as a component in nutrient solutions) and small-scale operations because of its high cost. The main objective of this study was to examine the efficiency of MKP as compared with commonly used PK fertilizers for cucumber and muskmelon when grown in the winter in containers with soilless media.

MATERIALS AND METHODS

Experiment I—1992/93

A parthenocarpic cucumber (cv. Hazera 258) and a Galia-type muskmelon hybrid (cv. Gala) were seeded in 10-liter pots containing tuff gravel (Wallach et al., 1992) and peat (2:1 v/v) on 11 November 1992. Plants were fertilized with two different sources of P and K: H_3PO_4 + KCl (HP+K) and MKP. The commercial MKP used contained 52% P_2O_5 and 34% K_2O (23% and 28% P and K,

RESULTS AND DISCUSSION

Seedling Growth

There were no differences in the seedling growth rate in the range of 100-400 ppm PK, therefore average values are presented (Table 1). In both species, PK deficiency (control) inhibited vegetative growth, and HP+K or MKP were effective in enhancing seedling growth. Control seedlings of cucumber and muskmelon were characterized by a higher shoot dry matter percentage than seedlings grown with various rates of PK nutrition. Under the same winter greenhouse conditions, cucumber seedlings developed faster than muskmelon seedlings.

Vegetative growth of cucumber seedlings was significantly affected by the medium, being most rapid in the media rich in organic components (PM and TC), intermediate in the NY soil and MS sand, and slowest in tuff (TG) (Table 2). Generally, increasing the PK rate enhanced vegetative growth. However, there were significant interactions between media and PK nutrition. The MKP had no effect on vegetative growth in TC, promoted the growth to the same degree by 100 or 500 ppm in PM and TG, and enhanced the growth by 500 ppm but not by 100 ppm in MS and NY media (data not presented).

Cucumber Yield

Application of a low rate of PK either as HP+K or as MKP significantly decreased the yield of cucumbers in each of the three months of harvest in 1992/

TABLE 1. Effects of PK source on the vegetative growth of cucumber and muskmelon seedlings 25 days after initiation of nutrition treatments (Newe Ya'ar, winter 1992/93).

Treatment	Leaves (no.)	Stem Length (cm)	Shoot Dry Weight (g)	Shoot Dry Matter (%)
Cucumber				
control	5.7 b[3]	38 c	1.7 c	9.8 a
HP+K[1]	6.7 a	54 a	2.3 a	8.1 bc
MKP[2]	6.5 a	49 b	2.1 b	8.4 b
Muskmelon				
control	4.5 c	25 d	1.0 e	10.6 a
HP+K	4.9 c	35 c	1.2 d	8.0 bc
MKP	5.2 bc	39 c	1.3 d	7.1 c

[1] H_3PO_4+KCl mean of 100, 200, 300, and 400 ppm PK.
[2] KH_2PO_4 mean of 100, 200, 300, and 400 ppm PK.
[3] Statistical separation within columns according to Duncan's Multiple Range Test (P=0.05).

TABLE 2. Effects of media and MKP rate on the vegetative growth of cucumber seedlings 19 days after initiation of nutrition treatments (Newe Ya'ar, winter 1993/94).

Treatment	Leaves (no.)	Stem Length (cm)	Shoot Dry Weight (g)	Shoot Dry Matter (%)
Medium				
Noy Yizre'el (NY)	4.9	35	2.3	8.8
Mediterranean sand (MS)	4.9	32	1.8	8.2
Tuff gravel (TG)	4.1	27	1.4	8.8
Peat moss (PM)	5.8	50	3.2	7.6
Tuff + compost (TC)	5.6	48	3.2	8.4
PK concentration (ppm)				
20	4.8	36	2.1	8.6
100	5.1	40	2.4	8.3
500	5.3	40	2.6	8.2
LSD (P=0.05)				
Medium	0.76	4.6	0.29	1.00
PK	0.46	3.8	0.24	NS[a]
Interaction	*[b]	*	*	NS

[a]NS - not significant.
[b]*Significant.

93 (Table 3). This yield reduction was the result of less fruit setting as the mean fruit weight of control plants was equal to the mean fruit weight of all other PK treatments. Control plants produced about 19 fruits per season, compared with 29-40 fruits per plant in the other PK treatments. Average fruit weight was very uniform in all the treatments and ranged between 68 and 74 g. There was also no difference among treatments in the percentage of off-shaped fruits. A PK concentration between 100 and 400 ppm did not affect cucumber yield in the first two months of harvest, but in the third month the yield was raised with increased PK concentration in the nutrient solution. This effect was also reflected to some degree in the total yield. In the first two months of harvest, there was no difference in the yields achieved by the different PK sources. In contrast, in the third month the average yield of plants supplied with MKP was 15% higher than that of plants supplied with HP+K. The total yield difference between PK sources was significant at the highest fertilizer level only. Significant interactions between medium and responses to PK nutrition were obtained in the 1993/94 experiment (Table 4). Under controlled conditions (minimal supply of PK), there were large significant differences in total yield among the media, with the highest yield in TC medium, intermediate in NY and PM, and lowest in TG. In contrast, all media excluding

TABLE 3. Effects of PK level and source on the yield (kg/plant) of cucumber cv. Hazera 258 (Newe Ya'ar, greenhouse, winter 1992/93).

PK Concentration (ppm)	First Month		Second Month		Third Month		Total	
	HP+K[1]	MKP[2]	HP+K	MKP	HP+K	MKP	HP+K	MKP
20 (control)	0.29 c[3]	0.28 c	0.49 c	0.56 c	0.49 ef	0.43 f	1.27 e	1.27 e
100	0.56 ab	0.54 ab	1.02 b	1.13 ab	0.57 de	0.66 d	2.15 d	2.33 d
200	0.50 b	0.60 a	1.10 ab	1.03 b	0.79 c	1.06 b	2.39 cd	2.69 a-c
300	0.61 a	0.55 ab	1.18 a	1.03 b	1.00 b	1.09 b	2.79 ab	2.67 a-c
400	0.58 a	0.59 a	1.03 b	1.15 ab	1.04 b	1.24 a	2.65 bc	2.98 a

[1] H_3PO_4+KCl.
[2] KH_2PO_4.
[3] Statistical separation within each month and total yields according to Duncan's Multiple Range Test (P=0.05).

TABLE 4. Effects of media and MKP level on the yield (kg/plant) of cucumber cv. Sarig (Newe Ya'ar, greenhouse, winter 1993/94).

Medium	PK Concentratiom (ppm)	First Month	Second Month	Third Month	Total
Noy Yizre'el (NY)	control	0.78 c[1]	0.66 c-e	0.30 cd	1.74 e-g
	100	0.86 c	0.55 ef	0.25 ef	1.66 fg
	500	1.14 b	0.63 c-f	0.32 cd	2.09 a-d
Mediterranean sand (MS)	control	0.59 d	0.38 g	0.12 g	1.09 h
	100	0.91 c	0.58 d-f	0.29 de	1.78 e-g
	500	0.90 c	0.67 cd	0.24 f	1.81 d-g
Tuff gravel (TG)	control	0.30 e	0.28 g	0.12 g	0.70 i
	100	0.83 c	0.71 bc	0.39 b	1.93 c-f
	500	0.91 c	0.87 a	0.53 a	2.31 ab
Peat Moss (PM)	control	1.14 b	0.30 g	0.10 g	1.54 g
	100	1.22 ab	0.54 f	0.24 f	2.00 b-e
	500	1.40 a	0.58 d-f	0.28 de	2.26 ab
Tuff + Compost (TC)	control	1.08 b	0.89 a	0.42 b	2.39 a
	100	1.09 b	0.73 bc	0.31 cd	2.13 a-c
	500	1.23 ab	0.80 ab	0.34 c	2.37 a

[1]Statistical separation within columns according to Duncan's Multiple Range Test (P=0.05).

TABLE 5. Effect of source and level of PK on earliness, fruit netting, TSS, and fruit shelf life in cv. Gala muskmelon (Newe Ya'ar, winter 1992/93).

PK concentration (ppm)	Earliness[1]		Netting[2]		Total Soluble Solids (TSS)		Firmness[3]	
	HP+K	MKP	HP+K	MKP	HP+K	MKP	HP+K	MKP
20 (control)	70 a[4]	72 a	1.2 f	1.4 f	12.4 a	12.4 a	2.8 a	2.6 ab
100	61 b	52 b	4.0 ab	3.0 d	11.4 ab	10.2 b	2.8 a	2.2 b
200	61 b	57 b	3.6 bc	4.0 ab	11.8 a	12.4 a	2.2 b	2.6 ab
300	60 b	53 b	3.4 cd	4.0 ab	11.5 ab	11.2 ab	2.2 b	2.2 b
400	56 b	59 b	4.1 a	4.2 a	12.3 a	12.0 a	2.4 ab	2.4 ab

[1]Days from seeding to anthesis.
[2]0=no netting, 1=<20% netting, 2=20-40% netting, 3=40-60% netting, 4=60-80% netting, 5=>80% netting.
[3]1=very soft, 2=soft, 3=hard. Data were recorded after 7 days of shelf life at 20±2°C under natural lighting and at 80±10% RH.
[4]Statistical separation in each parameter according to Duncan's Multiple Range Test (P=0.05).

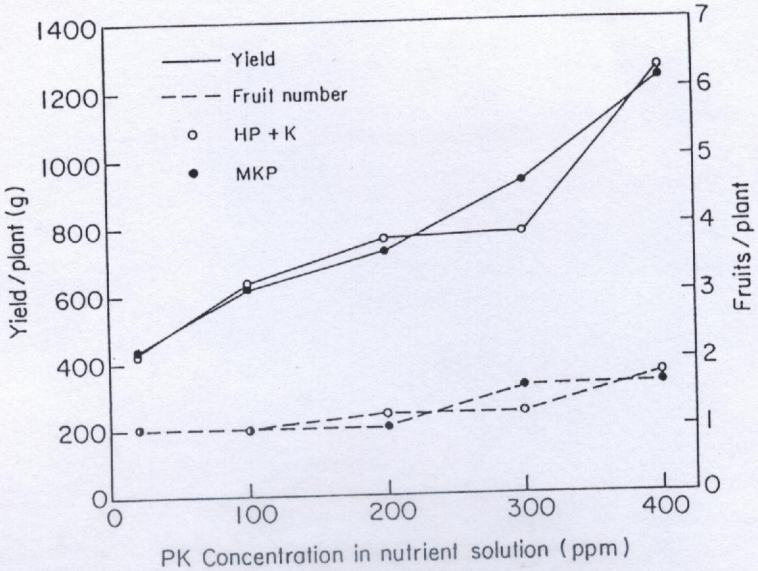

FIGURE 1. Effects of source and level of PK on fruit number and yield per plant in 'Gala' muskmelon (Newe Ya'ar, winter 1992/93).

MS produced about the same yield under the highest PK nutrition level. In NY soil, fertilization with 100 ppm PK was ineffective and with 500 ppm increased the yield in the first month only. In MS, PM, and TG media, fertilization with PK was very effective and increased the yields throughout the harvest season. In MS sand and PM, there were no large differences between 100 and 500 ppm, but in TG the yields at 500 ppm were higher that at 10 ppm. The TC medium was the only one in which PK did not increase the yield even at the higher level. The highest early yield (first month) was obtained in TC and PM media whereas the highest late yield (third month) was obtained in TC and TG media.

Muskmelon Yield and Quality

Increasing the PK content in the nutrition solutions from 20 (control) to 400 ppm increased fruit number and fruit yield per plant 1.6- and 3.0-fold, respectively (Figure 1). Phosphorus and K deficiency inhibited the vegetative growth and delayed the flowering phase (Table 5), but the length of the period between anthesis and fruit maturation was not affected (51±3 days in all treatments). Less than 100 ppm PK in the nutrition solution reduced fruit netting significantly, but did not affect fruit firmness or TSS values. There were no significant differences between the effects of the two PK sources with respect to yield and fruit quality characteristics.

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Zinc Nutrition of Silage Corn Grown on Acid Podzols

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ABSTRACT

Field studies were conducted at Bouctouche Research Farm in New Brunswick, Canada to determine the effect of zinc (Zn) and nitrogen (N) on silage corn. Soils at these sites are coarse texture loamy sand with pH values of 6.0-6.3 and organic matter content of 2.6 to 2.7 $mg \cdot g^{-1}$. In Experiment 1, Zn application at 0.5 to 1.0 $kg \cdot ha^{-1}$ foliar or 10 to 20 $kg \cdot ha^{-1}$ soil applied significantly increased the silage corn dry matter yield. Leaf Zn levels of 8.8 to 10.1 $mg \cdot kg^{-1}$ and available soil Zn at 0.8 $mg \cdot kg^{-1}$ in the check treatments were related to Zn deficiency in corn. No response to Zn was noted in Experiment 2 and this was associated with leaf Zn levels of 15 to 16 $mg \cdot kg^{-1}$ in the control treatment. In the Zn x N field study, a significant dry matter yield response to N and Zn was obtained. Nitrogen applications with or without added Zn increased leaf Zn. Leaf Zn increases were highest at the highest rate of added N. Corn leaf Zn levels at 9 $mg \cdot kg^{-1}$ were associated with lower yield. Zinc deficiency in corn can be controlled by 1 kg Zn ha^{-1} foliar or 10 to 20 kg Zn ha^{-1} soil applied.