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Muskmelon Responses to Controlled-Release N and K Fertilizers

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ABSTRACT

Application of controlled-release formulations of N & K are possible fertilizer practices which could improve plant growth and yield in South Texas. Application of N & K fertilizer in formulations of 0, 37.5%, and 75% controlled-release, and K application at 0, 30 and 60 kg K_2O ha $^{-1}$ obtained by combining non-coated and resin coated urea and KNO_3, were evaluated on melon [*Cucumis melo* (L.) var. reticulatus 'Mission'] production. Initial soil fertility levels were very high including 32.6 ppm NO_3^- −N and 955 ppm K. A response to K application in plant and root growth was observed in young vines, but this effect did not persist. Nitrogen application resulted in more foliage as determined by a visual rating. However, both N and K application seemed to cause about a 2 day delay in fruit maturity. Final soil analysis for N and K showed no effect due to fertilizer application. The practices evaluated in this study may be beneficial under some circumstances; however, this will probably occur only where soil nutrient deficiencies limit crop growth.

RESUMEN

El uso de formulaciones de liberación controlada y la aplicación de potasio como posibles prácticas de fertilización podrían mejorar el crecimiento vegetal y los rendimientos en el sur de Texas. Se evaluó el efecto de diferentes radios de fertilizantes de liberación controlada y de diferentes niveles de potasio sobre la producción de melón. Los niveles de fertilización inicial del suelo, incluyendo nitrógeno y potasio, fueron muy altos. Una respuesta a la aplicación de potasio en el crecimiento de la planta y de la raiz fué observado en enredaderas jóvenes, pero este efecto no persistió. La aplicación de nitrógeno resultó en un follaje más vigoroso, lo cual se determinó mediante una evaluación visual. Sin embargo, tanto la aplicación de nitrógeno como de potasio pareció retardar la madurez de los frutos. Los análisis del suelo finales mostraron la ausencia de algún efecto debido a la aplicación de fertilizante. Las prácticas evaluadas en este estudio pueden ser benéficas bajo ciertas circunstancias; sin embargo, esto probablemente ocurrirá solamente donde las deficiencias nutricionales del suelo limiten el crecimiento del cultivo.

Nitrogen (N) is the primary plant nutrient needed to be applied for vegetable production in the Lower Rio Grande Valley of Texas (LRGV). However, the rate and method of application are less clearly defined. N fertilizer is typically readily oxidized to the NO_3^- form which is subject to loss by leaching. Current recommendations for melons suggest application of 112 to 134 kg N ha^{-1} (100 to 120 lbs N ac^{-1}), preferably in split applications (Stein et al., 1990). Most research studies, however, have documented either no response, or yield increases only up to about 67 kg N ha^{-1} applied preplant (Pennington and Thompson, 1982). Various practices have been considered in order to improve nutrient availability and use efficiency, and to reduce losses in cucurbits. These practices include foliar applications (Wiedenfeld, 1984), the use of slow-release fertilizers, and improved placement and timing. However, the success of these practices has been limited (Wiedenfeld, 1979; Wiedenfeld, 1986).

Potassium (K) is available in the soils of the LRGV, both from the kaolinitic minerals in the parent material and from the irrigation water. Howerver, supplemental K is often recommended for crops such as melons to improve quality or yields. The reason given is that the plant is not able to take up this nutrient fast enough when it is most needed, or as a disease suppressant. The only study that evaluated K on melons in the LRGV proved that K application did not affect total yield, and maturity of the melons was delayed by higher rates of K (Hipp and Correa, 1967).

This study was conducted to evaluate controlled-release N and K fertilizer through resin coating, and to determine the effect of K application on cantaloupe growth and yield.

MATERIALS AND METHODS:

The study was conducted in a commercial field in Starr County in the spring of 1992 on a McAllen fine sandy loam soil (fine-loamy, mixed, hyperthermic Aridic Ustochrepts). The field was bedded up into rows spaced at 203 cm (80 in.), and subsurface drip irrigation tubing was installed in the middle of each row.

Treatments consisted of an unfertilized check and N application at 100 kg ha^{-1} combined with K application at 0, 30 and 60 kg K_2O ha^{-1}. N and K fertilizers were applied in formulations of 0%, 37½%, and 75% controlled release. These formulations were obtained by combining urea, KNO_3, and resin coated urea and KNO_3 (Multicote, Haifa Chemicals Ltd., Haifa, Isreal) in different ratios. This resulted in 10 treatments consisting of the factorial combination of 3 slow release levels and 3 K levels plus the unfertilized check. Treatments were replicated four times in a randomized block design. Plots were a single row wide by 15.25 m in length. Fertilizers were applied on 7 February in bands below and to both sides of the plant row.

The rows were covered with black plastic mulch and plants were planted in late February by direct seeding 'Mission' muskmelon. Other than fertilization, the study area received the same management as the rest of the field in commercial production.

Measurements were taken to determine initial and final soil fertility status, plant growth and nutrient uptake, and yield. Soil samples were taken prior to fertilizer application and planting. Two samples were obtained from each block, and each was a composite of surface soil taken from 5 randomly selected places from half of the plots in that block. These soil samples were air dried, ground, and analyzed for macro and micronutrients, organic matter, pH and salinity by the Extension Soil Testing Laboratory (Texas Agric. Extn. Service, College Station, TX) (Donohue, 1992). Plant samples were taken on 30 April by digging up one whole plant from each plot and separating the tops and roots. The area dug was approximately 61 cm across by 30.5 cm along the row by 20.3 cm deep. Roots were rinsed to remove excess soil. The samples were oven dried, weighed, ground, and analyzed for N concentration using a wet acid digestion and a Wescan® Ammonia Analyzer (Alltech Associates, Deerfield, IL). Vine vigor ratings were made in each plot on 19 May using a scale of 1 to 10 with 1 being healthy and 10 being dead. Yields were determined by harvesting all melons in each plot as they reached maturity, or at full slip. Harvests were made 16 times between 11 and 29 May. Melons were divided into size classes, then the number of melons and total weight for each size class were determined. Finally, post-harvest soil samples were taken from each plot. These samples were treated the same as the preplant soil samples, and were analyzed for macronutrients, pH and salinity by the Extension Soil Testing Laboratory.

All data were statistically analyzed using analysis of variance, with the 10 treatment means compared using Duncan's multiple range test, and main effects (N application, K rate, % slow release) compared using orthogonal polynomial contrasts (SAS Institute Inc., 1988)

RESULTS AND DISCUSSION

Soil samples taken preplant showed very high initial $NO_3^- - N$ (32.6 ppm) and K^+ (995 ppm) levels in the soil. Also, other plant nutrient levels were high to very high (Table 1), the organic matter content was low at 0.5%, the pH was 8.4 to 8.5, and there was no salinity hazard. Fertility did not appear to be a major factor limiting plant growth.

Plant samples taken before the first harvest showed a significant increase in both vine and root dry weight with K application (Table 2). This was found even though preplant soil testing had shown K levels more than 3 times greater than what would be considered very high (>300 ppm). Nitrogen concentration in the plants was not affected by any fertilizer treatment.

The mechanism of the K stimulation of plant growth was not known, but reduced disease incidence was considered as one possibility. Therefore, vine health ratings were made on 19 May. These ratings showed that N application resulted in healthier and more vigorous vines, but that K application had no significant effect (Table 2).

Cumulative melon yields over time showed that N fertilizer application tended to delay melon maturity in the early stages of the harvest period as shown by significant differences in cumulative yields after the second through sixth pickings (Fig. 1A), but final melon yields were not affected by N application (Table 3). Similarly, K application seemed to delay melon maturity (Fig. 1B) similar to results reported by Hipp and Correa (1967). Again early differences in yield due to K application disappeared by the end of the harvest period (Table 3). Controlled-release, however, seemed to enhance earliness slightly (Fig. 1C), although the only significant advantage was for the 75% controlled-release on 14 and 15 May, and the differences were small. Again differences observed did not persist through the final picking. Final melon yields after 19 days of picking showed no statistically significant differences between the treatments applied (Table 3).

Final soil tests taken on 19 May near the end of the study (Table 1) showed some unusual differences when compared to the initial samples taken in February. Nitrate-N and K were substantially lower, as were most of the other nutrients measured, but they were still rather high. Salinity was higher, but was well below the level of 600 ppm which is the minimum level considered to be a slight hazard to a crop. There were no treatment effects on any of the soil parameters measured at the conclusion of the study.

Table 1. Soil test analyses of samples taken preplant (17 February) and after the harvest (19 May).

Test	NO_3 -N	P	K	Ca	Mg	Na	S	salinity	pH
				ppm					
Preplant[z]									
mean	32.6	>190	955	17,700	482	137	199	341	8.5
std. dev.	4.6		64	5240	68	21	60	76	
After Harvest									
mean	6.3	>190	483	12,400	334	86	60	475	8.4
std. dev.	3.2		53	4009	43	9.5	13	156	

[z]Other analysis run on samples taken preplant: Zn - 0.26 ppm, Fe - 4.4 ppm, Mn - 3.7 ppm, Cu - 0.56 ppm, organic matter - 0.5%.

CONCLUSIONS

The study location had very high levels of most plant nutrients in the soil, either as residual from what had been applied to previous crops, or as a result of the high native fertility of the

Table 2. Effects of N application, K_2O rate, and percent slow release on musk melon plant and root dry weights and N concentrations 11 days before the first picking, and a foliage disease rating 8 days after the first picking.

N rate	K_2O rate	slow release	dry weight plant	dry weight root	N conc.	disease rating
kg ha⁻¹		%	*g*		%	
0	-	-	95	1.1	2.2	6.5
100	-	-	124	1.3	2.5	5.0
			NS[z]	NS	NS	*
100	0	-	98	1.1	2.4	4.9
100	30	-	139	1.5	2.5	4.8
100	60	-	135	1.4	2.4	5.3
			L*	Q*	NS	NS
100	-	0	104	1.2	2.4	4.9
100	-	37½	135	1.5	2.3	5.0
100	-	75	133	1.3	2.6	5.1
			NS	NS	NS	NS

[z]Means for each main effect (N application, K_2O rate, or % slow release) were compared using orthogonal polynomial contrasts. Differences were non-significant (NS), linear (L) or quadratic (Q) at the 5% (*) confidence level.

Table 3. Effects of N application, K_2O rate, and percent slow release on total musk melon fruit yields by size class, and on average melon size.

N rate	K_2O rate	slow release	size class[z] 12's	15's	18's	23's	30's	culls	total	size
kg ha⁻¹		%				*Mg ha⁻¹*				*kg*
0	-	-	0.0[y]	13.9	10.9	8.6	0.9	1.5	35.8	1.04
100	-	-	0.1	17.0	12.1	6.8	0.6	2.7	39.0	1.07
100	0	-	0.1	16.2	14.2	7.5	0.8	2.1	39.6	1.09
100	30	-	0.2	17.9	10.7	5.5	0.5	3.1	37.8	1.07
100	60	-	0.1	16.9	11.5	7.5	0.6	3.0	39.6	1.06
100	-	0	0.2	18.8	11.1	7.1	0.6	2.9	39.6	1.05
100	-	37½	0.2	15.8	11.8	6.7	0.6	2.7	37.8	1.05
100	-	75	0.0	16.3	13.2	6.8	0.7	2.6	39.6	1.11

[z] Size classes are based on the number of fruit that will fit into a standard carton.

[y] Main effect means (N application, K_2O rate, or % slow release) were compared using orthogonal polynomial contrasts. No statistically significant differences were found.

alluvial soils in the Rio Grande Valley. An unexpected stimulatory effect of K application on early plant growth was observed, but it was temporary and did not result in any yield benefit. The crop may have benefited from K application when the plants were very young and had a root system too small to take advantage of the abundant nutrient supply in the soil. Nitrogen application tended to cause more vigorous growth than where none was applied. Both N and K application seemed to delay fruit maturity, possibly a result of luxury consumption of the nutrients inhibiting ripening. High nutrient levels are known to delay maturity in many crops, often as a result of the plant partitioning assimilate to vegetative rather than reproductive growth and development. Controlled-release coating, at least at the higher rate, may have reduced or delayed nutrient availability enough to offset this effect. The lack of fertilizer responses in the final yields was not unusual since so much of the various nutrients were presented initially in the soil.

Some benefits due to K application and controlled-release mechanism are possible, but his study indicates that they will likely occur only under certain circumstances. When residual nutrients are high as in this study, there is little justification for applying any fertilizer, and no benefit from the added expense of controlled-release products should be expected.

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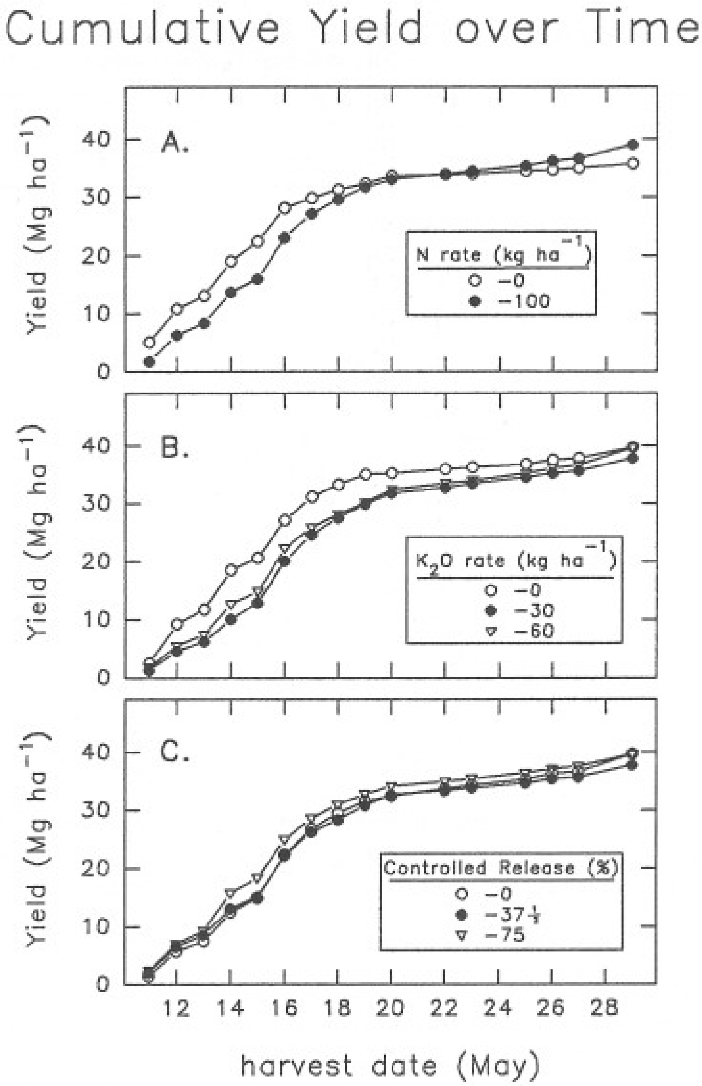

Fig. 1. Cumulative muskmelon fruit yields over time for N vs no N applied, for different K_2O rates applied, and for different percentages of the total N and K fertilizer as controlled release.