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Nitrogen Fertilizer Requirements of Pickling Cucumbers Grown for Once-over Harvest I. Effect on Yield and Fresh Quality[1]

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Abstract. **Different preplant and sidedress N fertilizer rates from NH_4NO_3 or urea were applied to pickling cucumbers (*Cucumis sativus* L.) grown for once-over harvest to determine the effect of N rate, source and time of application on cucumber yield, sex expression, and fruit quality. Nitrogen preplant rates of 67 or 134 kg/ha resulted in greater yields ($/ha and MT/ha) than no N preplant fertilizer. Preplant rates of 201 or 268 kg N/ha gave lower yields. The preplant source of N, NH_4NO_3 or urea had no effect on yield. Sidedress N as NH_4NO_3 or urea generally did not influence yields ($ and MT) when preplant N was used at rates of 67 or 134 kg/ha. The addition of preplant N fertilizer up to 134 kg/ha resulted in a slightly greater number of pistillate flowers per plant. The percentages of off-shape fruit were higher for the highest rate (268 kg/ha) of preplant N. Fruit quality evaluation (shape and color) and length:diameter ratios were generally not influenced by preplant N fertilizer.**

Individual fertilizer recommendations for multiple hand picked pickling cucumbers generally prescribe from 34 to 134 kg N/ha applied before planting with 1 to 2 additional sidedress applications of 28 to 45 kg N/ha. The total quantity of N recommended is dependent on soil type and rainfall. However, sidedress applications are generally recommended regardless of environmental factors.

Reports of previous fertility studies on pickling cucumbers list varied results. Dearborn (3) observed that plants supplied with low amounts of N fertilizer grew slowly and produced fewer and smaller fruits than plants receiving high rates of N. In comparing growth responses to N, Ca, K and Mg Reynolds and Stark (9) reported that variations in N level produced the greatest effect on vegetative growth. Greatest fruit number occurred on plants receiving a medium supply of N compared to very low or high amounts. McCollum and Miller (6) observed a positive yield response of cucumbers with increasing increments of N fertilizer up to 90 kg/ha. Wittwer and Tyson (11) and Ries and Carolus (10) found no benefit of supplemental N, except on low fertility, poorly drained soils.

Other researchers showed that cucumbers respond more to P than to other elements (1, 7, 11). Miller et al. (7) surveyed 19 cucumber fields and found that high yields were associated with a good supply of N and P. Reynolds (8) was unable to observe differential responses to fertilizer applied to cucumbers grown on fertile soil.

Most, if not all, of the published research on fertilizer studies with pickling cucumbers deal with low population multiple harvest production systems. The objective of this study was to determine the rate, source and time of application of N fertilizer applied to pickling cucumbers grown at high plant population for once-over harvest to produce maximum yield and fruit quality.

Materials and Methods

Cucumber (*Cucumis sativus* cv. Pioneer) seeds were planted at Simcoe, Canada, June 6, 1971; June 6, 1972; and May 30, 1973 in coarse sandy loam soils with a Stanhay seeder. The soils used each year tested low in organic matter and N, and medium to high in P, K, Ca and Mg. They had a pH of about 6.5. The seeds were placed 8 cm apart in rows 30 cm apart. The rows were in beds 7.6 m long with 1.5 m centers and 4 rows to a bed to give a population equivalent to 250,000 plants per ha. In all 3 years, treatments were replicated 4 times in a split-split plot design. In 1971 an additional population of 450,000 plants per ha was seeded as above in 6 rows per bed. Fertilizer P (294 kg/ha) and K (558 kg/ha) were broadcast and disked in at planting.

1971 Experiment: Nitrogen was applied preplant broadcast and disked in at rates of 67 kg/ha and 134 kg/ha N from NH_4NO_3. Just before the vines began to run (June 15), topdress treatments of N as either urea or NH_4NO_3 were applied within each preplant rate at rates of 0, 28, 56, 84, or 112 kg N/ha. These treatments were followed immediately by 1.5 cm of irrigation water.

1972 Experiment: Preplant N as NH_4NO_3 was applied broadcast and disked in at rates of 0, 67, 134, and 268 kg N/ha. Sidedress treatments were applied on June 28 in the same manner as in 1971.

1973 Experiment: Nitrogen was applied preplant broadcast and disked in as urea or NH_4NO_3 at rates of 0, 67, 134 and 201 kg N/ha. Sidedress treatments were applied within each souuce and rate on June 29 at rates of 0, 28, and 84 kg N/ha as urea or NH_4NO_3.

Dynap (dinoseb + naptalam) was applied immediately after seeding for weed control. Recommended practices in Ontario for disease and insect control were followed. Irrigation was used after the herbicide application and during fruit development to supplement rainfall. One hive of bees per 50,000 plants was present.

All the fruit from 5 m of bed was harvested by hand, graded and weighed when 10% of the fruit reached 4.1 cm in diam. The grades and dollar values were: less than 1.9 cm fruit diam ($253 Canadian/MT), 1.9 to 2.5 cm ($171/MT), 2.5 to 3.2 cm ($149/MT), 3.2 to 3.8 cm ($83/MT), 3.8 to 4.1 cm ($61/MT), 4.1 to 5.1 cm ($28/MT), and over 5.1 cm ($22/MT). The percentage of offshape fruit, "nubs," and "crooks," was determined from 25 randomly sampled fruit from each replication. Length:diam (L:D) ratios were measured on 10 randomly sampled cucumbers in the 1.9 to 4.1 cm size grades from each replication. Fresh quality was measured on a 25-fruit random sample from each replication. At harvest time, the number of pistillate flowers were counted to node 15 on 10 randomly sampled plants from each replication.

Results

In 1971, increasing the amount of preplant N fertilizer from

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Table 1. Effect of plant population, preplant N, and sidedress N on yield of pickling cucumbers harvested once in 1971.

	Yield					
	Preplant N (kg/ha) as NH_4NO_3			Sidedress		
					Source	
Plants/ha	67	134	Population mean	Rate (kg N/ha)	NH_4NO_3	Urea
	$/ha				*$/ha*	
250,000	1092a[z]	1547lb	1320a	0	1485a[y]	1569a
450,000	1312a	1715b	1515b	28	1468a	1502a
Mean	1203a	1631b		56	1280a	1366a
				84	1362a	1421a
				112	1290a	1429a
	MT/ha				*MT/ha*	
250,000	15.5a	23.8b	19.5a	0	21.1a	23.3b
450,000	17.0a	24.4b	20.9a	28	20.4a	20.9ab
Mean	16.1a	24.2b		56	17.9a	20.2ab
				84	19.7a	18.8a
				112	19.3a	20.4ab

[z]Mean separation within type of yield, by Duncan's multiple range test, 5% level.

[y]Data for both plant populations and preplant N treatments are combined.

Table 2. Effect of preplant N (as NH_4NO_3) and sidedress N on yield of pickling cucumbers harvested once in 1972.

	Yield					
Preplant N rate and sidedress source	Sidedress rate (kg/ha)					
	0	28	56	84	112	Mean
Preplant N (kg/ha)			*$/ha*			
0	638b[z,y]	746d	692c	524a	776d	675b[x]
67	862b	838a	890b	897bc	949c	887c
134	860a	904b	1008c	991c	979c	949c
268	255a	439c	410c	398bc	363b	373a
Sidedress source						
NH_4NO_3	655a[w]	719a	756a	687a	734a	712a
Urea	652a	744ab	744ab	717ab	798b	731a
Preplant N (kg/ha)			*MT/ha*			
0	7.4b	9.0cd	8.5c	6.3a	9.6d	8.1b
67	11.0a	10.3a	10.5a	11.0a	11.0a	11.8c
134	11.2a	11.4ab	12.6c	12.3ab	12.8c	12.1c
268	3.6a	5.8c	6.1c	5.8c	4.9b	5.2a
Sidedress source						
NH_4NO_3	8.3a	9.0a	9.4a	9.0a	9.4a	9.0a
Urea	8.3a	9.2ab	9.2ab	8.5a	10.3b	9.2a

[z]Mean separation in rows within type of yield, by Duncan's multiple range test, 5% level.

[y]Grand mean separation in columns within type of yield by Duncan's multiple range test, 5% level.

[x]Data for sidedress treatments are summarized for all preplant N treatments at each rate.

[w]Data for sidedress treatments summarized for both N sources.

67 to 134 kg/ha resulted in greater yields ($/ha and MT/ha) of cucumbers harvested once-over for both populations (Table 1). Additional N sidedressed as either NH_4NO_3 or urea from 28 to 112 kg N/ha did not increase yields over a no sidedress control. Mean yields as $/ha were higher at the 450,000 plant/ha population. The effect of preplant N fertilizer on yield was independent of plant population. This higher $/ha yield was due primarily to a greater number of smaller pickles at the higher population since the tons/ha were nearly the same at both populations.

Yields (both $ and MT) were greater by using 67 or 134 kg N/ha preplant compared with no preplant N in 1972 (Table 2). Preplant N fertilizer at 268 kg N/ha gave lower yields than the control. This lower yield was probably partially due to the 20% reduction in plant stand caused by excessive N fertilizer. Within individual preplant rates, sidedress N fertilizer gave higher yields in some cases over the 0 sidedress rate. The source of N used as sidedress fertilizer was important since only urea significantly gave higher yields. The use of sidedress urea may have been important in 1972 because of heavy rainfall and cool weather early in the season which could have led to more leaching of NO_3 than NH_4 from the immediate root zone.

In 1973, $/ha yield was greater in treatments receiving 67 and 134 kg/ha preplant N and no sidedress N compared to the 0 preplant treatment receiving no sidedress N (Table 3). There was no difference in yield between 67 or 134 kg N/ha NH_4NO_3 preplant. Yield was lower with 201 kg N/ha compared to the control when either NH_4NO_3 or urea was used as the N source. The 201 kg N preplant rate did not affect plant stand. Possibly, root growth was adversely affected by the high N level. Sidedress N resulted in greater yield ($/ha) when no preplant fertilizer was used and at the 201 kg N/ha preplant rate. Nitrogen sidedress source had no influence on yield. Yields as $/ha were quite high in 1973 even in the plots that received no N

Table 3. Effect of preplant N and sidedress N on yield of pickling cucumbers harvested once in 1973.

N preplant		Yield ($/ha)				Yield (MT)/ha			
		N sidedress rate (kg/ha)				N sidedress rate (kg/ha)			
Source	Rate (kg/ha)	0	28	84	Mean	0	28	84	Mean
NH_4NO_3	0	2441a[z,y]	2560a	2807b	2603b[x]	32.7a	30.0a	31.8a	31.6ab
	67	2651b	2407a	2523ab	2528b	35.9b	29.1a	33.0b	32.7b
	134	2629b	2868b	2441a	2597b	28.2a	29.6a	26.9a	28.2ab
	201	1955a	2288b	2066a	2103a	24.3a	30.0b	28.0ab	27.8a
Urea	0	2409a	2629b	2580b	2538bc	27.8a	31.8b	33.4b	30.9a
	67	2513b	2251a	2476b	2414b	29.4b	25.3a	29.4b	28.0a
	134	2898b	2743a	2708a	2785c	35.0b	30.0a	27.8a	30.9a
	201	1816a	1994b	2202c	2004a	28.5a	26.7a	32.1b	28.9a
Mean									
NH_4NO_3		2360a[w]	2446a	2486a	2431a	29.4a	29.8a	31.4a	30.0a
Urea		2553a	2451a	2464a	2488a	31.4b	28.5a	29.4ab	29.8a

[z]Mean separation in rows within type of yield by Duncan's multiple range test at the 5% level.

[y]Data for sidedress treatments are summarized for both sidedress N sources, NH_4NO_3 and Urea.

[x]Grand mean separation in columns within type of yield by Duncan's multiple range test at the 5% level.

[w]Data for sidedress treatments are summarized for all preplant N treatments at each rate.

Table 4. Effect of preplant N fertilizer on flowering, fruit shape and fruit quality.

Preplant N (kg/ha)	No. pistillate[z] flowers/15 nodes	Offshape fruit[z] (%)	Fresh quality evaluation[y]	Lengh:diam ratio[x]
0	6.5	2.8	37.2	2.8
67	8.6	3.7	35.8	2.8
134	8.4	3.0	36.1	2.8
201	7.6	3.0	35.8	2.9
268	7.5	4.5	33.9	

[z]Data summarized for 1971, 1972 and 1973.

[y]Data summarized for 1972, 1973.

Point system for fresh quality evaluation:

A – Shape: Shoulder and stem attachement – 5 points; blossom-end taper – 5 points; and ridging and spines – 10 points.

B – Color: Green quality and stippling – 10 points and uniformity – 10 points.

[x]Data summarized for 1973.

fertilizer. The latter plots showed distinct signs of N deficiency leaf yellowing. The higher yields may be related to a temperature effect since average daily temperatures were higher during the 1973 growing season. Yield as tons/ha was generally unaffected by preplant N and sidedress N rate or source.

Female sex expression was slightly higher in all 3 years with increasing preplant N (Table 4). Sidedress N fertilizer essentially had no effect on sex expression. It is doubtful that the small influence on sex expression had any relationship to greater yields resulting from preplant N fertilizer.

The amount of preplant N fertilizer applied had little influence on fruit shape except at 268 kg/ha where there was about 2% more off-shape fruit than at the 0 N level. The preplant N fertilizer treatments had no apparent effect on fresh fruit quality evaluations over the 0 N preplant treatment. The fresh quality data recorded did not show any advantage for using higher amounts of N fertilizer from the standpoint of either overall fruit shape or color. Fruit L:D ratios were essentially unchanged with preplant fertilizer. Sidedress N did not influence L:D ratios.

Discussion

During the 3 years of this investigation, yield as $/ha or MT/ha of pickling cucumbers harvested once-over were highest when preplant N fertilizer was applied at rates of 67 or 134 kg/ha. Neither the source of preplant N nor plant population significantly influenced these results. If N fertilizer was applied at rates above 134 kg N/ha, lower yields resulted. These results are similar to those of McCollum and Miller (6) who showed that rates of N fertilizer above 180 kg N/ha did not improve yields of multiple-picked cucumbers over a rate of 90 kg N/ha. Bishop et al. (1) reported satisfactory yields from pickling cucumbers harvested several times when 50 kg N/ha were broadcast before planting. McCall et al. (5) observed maximum yields of pickling cucumbers to which the N fertilizer was broadcast before planting at rates to 56 kg/ha compared to sidedressed at planting.

Many areas recommend additional sidedress N fertilizer for a multiple harvest system to be applied when the vines begin to run. For a once-over harvest system this appears unnecessary. The results of this experiment show little yield benefit from extra sidedress N. In areas of heavy leaching a preplant N rate close to the 134 kg/ha rate may be more beneficial than 67 kg/ha in overcoming nutrient losses due to leaching. Ries and Carolus (10) found no benefit from supplemental N applications even in a season with above average rainfall. There also appears to be no benefit from urea as compared to NH_4NO_3 as the N source.

In 1973, yields were high without the addition of N fertilizer, even with the plants exhibiting apparent N deficiency symptoms. That was a particularly good year for pickle production as temperatures were generally above normal. Under good environmental conditions (7, 10, 11) N fertilizer may not improve cucumber yields.

Dearborn (3) reported that cucumbers grown with high N produced more pistillate and fewer staminate flowers than those grown with low N. In closely evaluating his data that difference was found to be very slight. In the present experiment that difference was likewise found to be small. It is doubtful whether the increase in femaleness led directly to increased yield since the number of fruit per plant was generally unaffected by N treatment.

Nitrogen was thought to have a profound influence on fruit quality, especially color since chlorophyll production is regulated by the availability of N. There were no apparent differences in fruit shape or color. Lloyd and McCollum (4) found no consistent differences in percentage of nubs due to differential rates of N fertilizer.

Hence, it appears that N rates between 67 to 134 kg/ha applied broadcast and disked in before planting will produce near maximum yields of pickling cucumbers harvested once-over. The source of N fertilizer, urea of NH_4NO_3 does not appear to be important. Additional sidedress applications of N fertilizer above the preplant applications do not appear to improve yields.

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