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Irrigation and Applied Nitrogen Effects on Snap Beans and Pickling Cucumbers[1]

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Abstract. **Field studies were conducted to determine the response of snap beans (*Phaseolus vulgaris* L.) and cucumbers (*Cucumis sativus* L.) to no, intermediate, and high irrigation with 0, 65, 100, and 135 kg N/ha on beans and 56 and 112 kg N/ha on cucumbers. Intermediate irrigation increased marketable yields, but high irrigation did not. Average snap bean yields for the 3-year period by soil water regimes were 5,800, 7,000, and 6,800 kg/ha, and for cucumbers were 32,200, 35,400, and 33,000 kg/ha for no, intermediate, and high irrigation, respectively. Applied N increased yields, with the 3-year average snap bean yields being 4,600, 6,600, 7,200 and 7,700 kg/ha for 0, 65, 100 and 135 kg/ha rates, respectively, and cucumber yields being 31,900 and 35,100 kg/ha for 56 and 112 kg/ha, respectively. There was a greater response to N fertilizer on the spring crop than on the fall crop.**

In areas with long frost-free periods, it is possible to grow more than 1 crop per season of certain vegetables such as snap beans and cucumbers. Frequently there is a market advantage from an early and late crop of these vegetables. One problem sometimes encountered in this type of management is occurrence of drought during the plant's critical maturity state. In central Alabama, there is a period of relatively low rainfall in May-June and again in the fall (13). Snap beans and cucumbers are planted in mid-April and mid-August. Snap beans are sensitive to water stress and high temp, especially during blossoming and pod growth (3, 4, 8).

The response of snap beans to P and K fertilizer has been both positive and negative, depending on past treatment and levels of these elements in the soil (5, 6, 12, 13, 14). The response to N has been positive, but the response usually has been limited to 35 to 85 kg N/ha. Worley and Harmon (14) reported that N reduced the percent marketable pods, but the effect was overcome by increase in yield.

Studies with cucumbers showed a positive response to 30 to 60 kg N/ha (1, 2, 9, 10, 11), while rates of 100 kg N/ha or higher had an adverse effect on yield by stunting plants (1, 9). Johnson et al. (7) reported that response of pickling cucumbers to N was variable, depending on the soil type. The greatest response was on eroded, upland soil, where 90 kg N/ha appeared to be the best rate. There was no benefit from applied N on highly productive soils. Inadequate N and/or K may adversely affect fruit length and shape of cucumbers (2) and an N × K interaction has been indicated (11).

The purpose of this experiment was to determine the effect of supplemental irrigation and applied N on marketable yields of snap beans and pickling cucumbers.

Materials and Methods

'Harvester' snap beans and 'Carolina' pickling cucumbers were grown in the field in central Alabama from 1973 to 1975 on a Lucedale fine sandy loam (Rhodic Paleudult). Crops were grown in both spring and fall except fall 1975 when the snap bean stand was too poor for harvesting. Both snap beans and cucumbers were grown at 3 soil water regimes with 4 N rates on snap beans and 2 N rates on cucumbers. There were 3 replications of a split-plot design, with soil water regime as main plots and N rates as subplots.

Irrigation levels tested were a) no irrigation, b) irrigation when 70% (intermediate irrigation), and c) irrigation when 40% (high irrigation) of the available soil water had been removed from the surface 60 cm of soil. Soil water suction was 2 bars for the intermediate treatment and 0.67 bar for the high treatment. Plants were furrow-irrigated to replenish the surface 60 cm of soil to field capacity. Available water-holding capacity of the soil was approx 1 cm/dm of soil. A dike was constructed around each plot to confine all rainfall and irrigation water. Irrigations were based on readings from gypsum soil moisture blocks for cucumbers and on gravimetric soil samples for snap beans. It some cases rainfall occurred immediately after irrigation, which caused excessive soil moisture in the soil profile for short periods of time.

Nitrogen rates from ammonium nitrate were 0, 65, 100, and 135 kg/ha for snap beans and 56 and 112 kg/ha for cucumbers. All plots were fertilized with P and K according to soil test. Spring crops were planted about April 15, and fall crops about August 10. Snap beans were harvested once over, to simulate machine harvesting, for each crop at about 55 days after planting for the spring crop, and about 65 days after planting for the fall crop. All plots were harvested on the same day when approx 50% of the pods were sieve size No. 4. Cucumbers were hand harvested at 2 to 3-day intervals, for a total of 9 to 16 harvests for each planting. Plants were sprayed weekly throughout the

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[3]Mention of a trademark name of a proprietary product does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture and does not imply its approval to the exclusion of other products that may also be suitable.

[4]Standard grades used by Pickle Packers International, St. Charles, Ill.

season for insect and isease control with cygon, sevin, and dithane M-45[3].

The long-time average rainfall for the periods April through June and August through Oct. for central Alabama is 36 and 25 cm, respectively, (Table 1). Rainfall during the test periods was above normal, except for fall 1973, when rainfall was only 75% of normal. Rainfall for the other periods ranged from 105 to 109% of normal, resulting in low irrigation requirements (Table 2).

Results and Discussion

Snap beans. Irrigation had little effect on snap bean growth and final plant ht except for the 1973 fall crop, when irrigated plants grew faster and were 10 to 15 cm higher than unirrigated plants at time of harvest. There was no difference in plant growth on intermediate and high soil water regimes. Rate of plant growth and final plant ht were increased by applied N, but the effect was mainly between no N and the lowest N rate, where plants were 12 to 18 cm higher. Applied N usually had a greater effect on plant growth in the spring than in the fall, probably as a result of residual N from the spring crop. The effect of applied N on plant growth was usually greater with irrigation than without.

Grading of pods indicated that neither irrigation nor applied N had a consistent effect on bean grade or size distribution for either spring or fall crop.

Table 1. Rainfall by 10-day periods throughout growing season for each year, 1973–75.

Period		Rainfall (cm/10-day period)				
		1973	1974	1975	Avg.	Normal
April	1–10	6.1	6.9	6.2	6.4	5.0
	11–20	3.0	4.5	10.3	5.9	5.0
	21–30	9.2	1.5	3.0	4.6	5.0
May	1–10	6.0	4.2	2.5	4.2	3.4
	11–20	2.7	2.0	5.4	3.4	3.4
	21–31	6.8	9.1	1.5	5.8	3.4
June	1–10	2.6	5.6	4.2	4.1	3.7
	11–20	2.3	3.8	4.3	3.5	3.7
	20–30	2.0	0	2.5	1.5	3.7
July	1–10	6.2	2.0	12.8	7.0	5.0
	11–20	2.7	1.7	1.9	2.1	5.0
	21–31	1.8	2.8	9.4	4.7	5.0
August	1–10	0.1	26.2	11.4	12.6	4.4
	11–20	3.4	0.6	4.3	2.8	4.4
	21–31	0.2	0.7	0	0.3	4.4
Sept.	1–10	3.5	9.1	6.2	6.3	2.4
	11–20	0.7	3.9	0.5	1.7	2.4
	21–30	3.1	5.4	9.0	5.8	2.4
Oct.	1–10	7.6	0	8.1	5.1	1.7
	11–20	0.2	1.9	5.3	2.5	1.7
	21–31	0.2	0	0.1	0.1	1.7

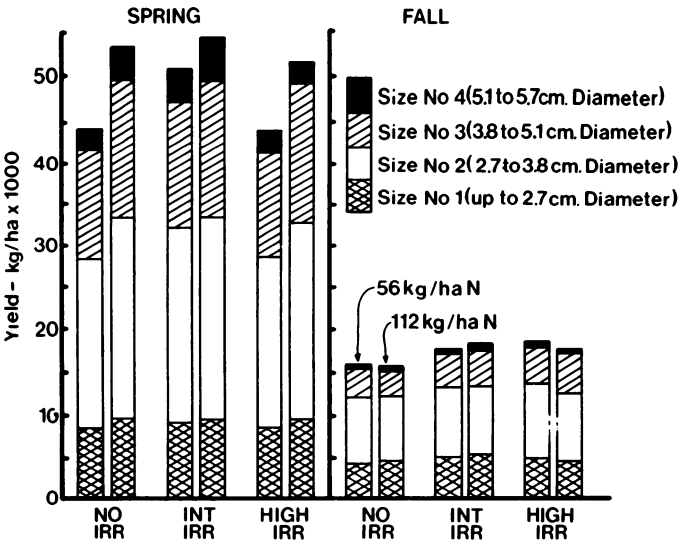

Fig. 1. Marketable cucumber yields by grade for spring and fall crops as affected by irrigation and applied N (avg 1973–75).

Irrigation had little effect on bean yields except in the fall of 1973 when rainfall was only 75% of normal (Table 3). Yields were almost doubled by irrigation in the 1973 fall crop, but there was no difference between intermediate and high soil water regimes. Averages for all years indicated no yield response to irrigation in the spring, but there was a positive response to the intermediate and high irrigation levels in the fall because of the dry fall in 1973. Applied N increased bean yields for all crops (Table 3). Yield increase from applied N was usually greater for the spring crop than for the fall crop and tended to be greater with irrigation than without, but the interaction of irrigation × N was not statistically significant. Bean yield increases were greater for the first increment of applied N than for the additional increments. For the spring crops, bean yield increase from applied N averaged 3,000 kg/ha for the 1st increment, 800 kg/ha for the 2nd increment, and 900 kg/ha for the 3rd increment. For the fall crops, yield increase from applied N averaged 1,000 kg/ha for the 1st increment of N, 400 kg/ha for the 2nd increment, and 200 kg/ha for the 3rd increment.

Pickling cucumbers. There was no apparent difference in seedling emergence and early growth of cucumbers from irrigation or from higher N rate. However, later in the season both irrigation and higher rate of N usually increased the amount of vegetative growth.

Irrigation increased marketable cucumber yields in 1973 but had no effect during the other 2 years (Table 4). Irrigation increased fall crop yields in 1973, with no difference between

Table 2. No. of irrigations and amount of water applied.

Year	Planting	Snap beans				Cucumbers			
		Int. irrigation		High irrigation		Int. irrigation		High irrigation	
		No.	Amount (cm)	No.	Amount (cm)	No.	Amount (cm)	No.	Amount (cm)
1973	Spring	0	0	2	6.4	1	4.4	4	6.4
	Fall	5	15.9	7	18.4	5	15.9	7	18.4
1974	Spring	0	0	0	0	1	4.4	3	10.8
	Fall	0	0	2	7.0	1	4.4	4	13.3
1975	Spring	1	4.4	2	7.0	1	4.4	3	10.2
	Fall	--	--	--	--	0	0	0	0

Table 3. Marketable snap bean yields as affected by irrigation and applied N.

Soil water regime	N (kg/ha)	Yields by year and crop (kg/ha) 1973 Spring	1973 Fall	1974 Spring	1974 Fall	1975 Spring	Avg Spring	Avg Fall
No irrigation	0	2200	4040	4460	3840	4280	3650	3940
	65	5190	4840	8190	6340	6030	6470	5590
	100	6700	5120	8490	5230	7220	7470	5180
	135	7080	5180	10300	5990	7520	8300	5580
Intermediate irrigation	0	2470	8510	5120	3970	3760	3780	6240
	65	5050	8950	7970	5220	8450	7160	7080
	100	6430	9240	8380	6320	8480	7760	7780
	135	7300	9710	9510	5340	9050	8620	7520
High irrigation	0	2400	8180	5360	3710	3550	3770	5940
	65	5210	8730	7590	4490	6860	6550	6610
	100	6060	9640	7360	5430	8820	7410	7540
	135	7000	11220	8650	4870	9460	8370	8040
				Overall avg.				
No irrigation		5290ns	4800b[z]	7860ns	5350ns	6260ns	6470ns	5070b
Intermediate irrigation		5310	9100a	7740	5210	7440	6830	71160a
High irrigation		5170	9440a	7240	4630	7170	6530	7030a
N rate	0	2360d	6910b	4980c	3840b	3860c	3730c	5370b
	65	5150c	7510ab	7920b	5350a	7110b	6730b	6430ab
	100	6400b	8000ab	8080b	5660a	8170a	7550ab	6830a
	135	7130a	8700a	9490a	5400a	8680a	8430a	7050a

[z]Column mean separation by Duncan's multiple range test, 5% level.

intermediate and high soil water regimes. Yields for the 1973 spring crop were decreased by high irrigation. Although rainfall for the 1973 spring period was 114% of normal, the high soil water regime was irrigated 4 times just before large rains. Since dikes were constructed around each plot to confine rainfall and irrigation water, this resulted in excessive soil

Table 4. Marketable cucumber yields as affected by irrigation and applied nitrogen.

Soil water regime	N (kg/ha)	Yields by year and crop (kg/ha) 1973 Spring	1973 Fall	1974 Spring	1974 Fall	1975 Spring	1975 Fall	Avg. Spring	Avg. Fall
No irrigation	56	48570	28940	39850	8650	43940	10200	44120	15930
	112	64640	26590	46740	10580	48460	9450	53280	15540
Intermediate irrigation	56	55280	34450	48030	8450	49570	10360	50960	17750
	112	65290	34640	49620	10340	48310	10020	54410	18330
High irrigation	56	43100	37080	42440	6700	46520	12230	44020	18670
	112	56400	34220	50650	8380	47610	10610	51550	17740
					Overall avg.				
No irrigation		56600a[z]	27760b	43300ns	9620ns	46200ns	9820ns	48700ns	15730b
Intermediate irrigation		60280a	34540a	48830	9400	48940	10190	52680	18040a
High irrigation		49750b	35650a	46550	7540	47060	11420	47790	18200a
N rate	56	48980b	33490ns	43440b	7930ns	46670ns	10930ns	46360b	17450ns
	112	62110a	31820	49010a	9770	48130	10030	53080a	17210

[z]Column mean separation by Duncan's multiple range test, 5% level.

moisture in the soil profile for short periods. 'Carolina', a gynoecious hybrid, can change its sex expression from pistillate to staminate with excessive vine growth. This, coupled with the excessive soil moisture levels encountered after heavy rain, could have caused the reduced yields from high irrigation plots. The average yields for all years indicated no yield increase from irrigation in the spring crop, but irrigation at the intermediate and high levels increased yields of the fall crop.

The higher N rate increased marketable cucumber yields for the spring crops of 1973 and 1974, but had no effects on the other crops (Table 4). The averages for all years indicated a higher yield from 112 kg N/ha than from 56 kg N/ha in the spring crops, with no difference between the 2 N rates in the fall crops.

Marketable yields were considerably higher in the spring than in the fall every year. Average yields for the 3-year period ranged from 44,000 to 54,400 kg/ha for the spring crop, and from 15,500 to 18,700 kg/ha for the fall crop (Fig. 1). Cucumbers were harvested to obtain small-size fruit for higher market prices. It is important to harvest when a large percentage of grades 1 and 2 can be obtained, since their value decreases sharply with size increases. The distribution of cucumber sizes is shown in Fig. 1 for both spring and fall crops. Average size distribution for all years indicated that total marketable cucumbers consisted of 19, 45, 30, and 6% for grade sizes 1, 2, 3, and 4, respectively, for the spring crop, and 35, 46, 16, and 3% for the fall crop.

Cull cucumbers ranged from 6 to 14% of the total wt harvested, and averaged 11% for the spring crop and 9% for the fall crop. Culls were mostly crooked and oversize fruits.

Conclusions

Above-normal rainfall during most of the test periods possibly prevented a response to irrigation except the 1973 fall crop for snap beans and the 1973 spring and fall crops for cucumbers. Tests indicated a beneficial effect of supplemental irrigation when rainfall was below average for the season. Snap beans were more responsive to applied N in the spring than in the fall. For cucumbers, 112 kg N/ha resulted in higher yields than 56 kg N/ha for the spring crop, with no differences between the 56 and 112 kg N/ha rates for the fall crop.

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