Vegetable Research Under Sprinkler Irrigation

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New developments in self-moving irrigation systems utilizing low pressure sprinkler, spray, or drop hose techniques show possibilities for saving energy, improving efficiency of water and fertilizer use, and using more saline water to irrigate crops that are salt sensitive. These new techniques in sprinkler irrigation have enlarged the possible combinations of soil, water and crops.

An experiment was designed to evaluate water and nitrogen conservation using sprinkler irrigation on various agronomic and horticultural crops grown on the sandy soils in southwestern Arizona. The sprinkler irrigation system used in this study is a self-moving lateral system. A statistical design with two variables, water and nitrogen, is used in this experiment.

This statistical design can determine the crop response function (yield) for the two variables; water applied (W.A.) and nitrogen applied (N). A total of nine different levels of water and nitrogen combinations are defined by this statistical design, with the center treatment replicated five times. This gives a total of 13 areas where different levels of water and nitrogen are applied.

The sprinkler system can apply light frequent irrigations and keep the soil moist during germination. Preliminary results indicate that seed planting depths can be shallow and that it is easier to germinate seeds under this sprinkler system than on the heavier soils that are flood irrigated. This sprinkler system offers little crop cooling during the summer or frost protection during the winter compared with a solid-set sprinkler system using impact sprinklers.

The irrigation water used in this study is Colorado River water having an average electrical conductivity of 1.4 ds/m (900 mg/l) of total dissolved salts. When nitrogen fertilizer is applied the total dissolved salts are raised by about 100 mg/l. No foliar damage due to salt accumulation has been observed at this time. Because this sprinkler system applied water at a very high rate for a short period of time no wetting-drying cycle takes place. It appears that the water is applied in a manner that keeps the leaves constantly wet during the irrigation cycle.

Observations made on the first crops planted showed that root development was quite shallow. Even though the infiltration rate is high, the sand particles appear to form a barrier that retards deep root penetration. Soil bulk densities can exceed 1.8 gms/cm. A chisel was used; however, it did not fracture the sandy soil as it does the heavier soils. Only those areas where the chisel passed through showed improved rooting depth.

A deep chisel plow was modified. The chisel points were removed and flat, wide shovel wings were installed. Pieces of 1-1/2" x 1-1/2" x 1/4" angle iron were welded on top of the wings. As the modified chisel moves, the soil is raised about 5 inches because of the angle iron pieces on the wings. Because of power restrictions and chisel size, we can only chisel to a depth of 18 in. Using this technique has resulted in a noticeable improvement in rooting depth from some crops, particularly carrots.

Initially, some crops were planted in beds similar to those used in growing crops under flood irrigation. During the first spring a windstorm filled the furrows of the first few rows, creating the effect as if the crop had been planted on the flat.

It was observed that plants growing on the flat appeared to be larger and greener and to mature less rapidly compared to those planted on beds. Closer observations revealed that as the sprinkler system moves across the field it applies water at a very high rate for a short period. Because this high rate of application is in excess of infiltration, water runs off the beds into the furrow and is lost to deep percolation. The result is non-uniform irrigation; more water is applied to the furrow compared to the bed.

It is also possible that the beds collected more heat and had higher temperatures compared to a flat area, encouraging earlier maturity. Row crops were then planted on the flat. A bed shaper has been developed to plant the fall row crops in the bottom of a small furrow. Excellent germination has been attained. It was noted that water collected in the furrow bottom, which aided in keeping the seeds moist. This required a smaller amount of germination water compared to planting on the flat or top of a bed.

Data from several vegetable crops are presented in Table 1. Data are shown for only those crops for which we feel reasonable yields were obtained. Yield data could not be obtained for some crops planted because of disease, germination, date of planting, water and/or fertility management problems. Research is continuing on these crops so that adequate yield data can be obtained.

Yield response equations determined for each of the crops shown in Table 1 will not be presented at this time. It is felt that three years of consistent data are needed before we can predict a yield response equation for a particular crop with any confidence. Many of the crops grown under the sprinkler system are not common to the Yuma Mesa, so the growing and cultural practices best suited to each crop may be different compared to where they are typically grown.

Asparagus yields would be considered above normal, averaging 11,000 lbs/ac. Results show that asparagus yields are affected by nitrogen applications, particularly in yield earliness. This is important since the market value is quite high during this period. It appears that asparagus requires 9 ft. of water and 310 lb/ac of nitrogen to obtain maximum yield.

Many of the row crops are planted on closer row spacings since furrows are not needed for irrigation. Thus, broccoli, cabbage, cauliflower and lettuce were all planted on 14-in. rows. Typically, broccoli, cabbage and lettuce are commercially planted 2 rows on 40-in. centers. The narrower row spacing allowed a higher plant population, which increased yields by about 25% over commercial yields. It requires about 18-24 in. of water and 200-275 lb/ac of nitrogen to grow these crops.

Commercially, carrots are grown in 6 lines on 40-in. centers and yields average 30 tons/ac. It was felt that the plant population could be increased and as a result yield also would increase. Carrots were planted on a 2 x 2-1/2 in. spacing which resulted in 1.25 million plants per acre. More work has to be done to develop the cultural practices for high carrot plant populations. However, yields of 70 tons/ac have been obtained to date.

Increased plant populations for cucumber and watermelons are not advantageous because these crops typically cover the entire soil surface under normal cultural practices. Excellent yields were obtained under sprinkler irrigation for these crops. Planting these crops early in the spring on the flat or in the bottom of a furrow has an adverse affect. Soil temperatures are cold and a raised bed is needed to increase the soil temperature to promote early germination and plant growth.

Potatoes have done quite well under sprinkler irrigation on the sandy soil. Ideally, a raised bed is needed early to increase the soil temperature and improve early germination and then later in the season when temperatures are high, no bed is preferred to minimize the soil temperature. Controlling water and nitrogen near maturity has increased the specific gravity which improves the chipping quality of the potatoes. Potato and sweet corn plant populations were not increased. Attempts to increase the populations did not economically increase yield.

Results indicate that these crops can be commercially produced on sandy soil using sprinkler irrigation. The modified chiseling technique and planting on the flat or in the furrow bottom are very important cultural practices for this type irrigation system.

TABLE 1. Summary of Yields and Cultural Practices for Vegetable Crops Grown under Sprinkler Irrigation on Superstition Sand, Yuma, Arizona.

Crop	Asparagus	Broccoli	Cabbage	Carrots	Cauliflower
Variety	Mary Washington	Excalibur	109 Hyb.	Imperator	Snowball 123
Number of harvests	60	5	4	1	3
Growing season - days	365	110	142	213	138
Row spacing - in	68 (double)	14	14	2½	14
Plant spacing - in	10	12	12	2	18
Plant population - per ac	20,000	37,000	37,000	1,250,000	25,000
Water applied - in	98	17	20	56	23
Nitrogen applied - lb/ac	310	260	210	300	275
Marketable yield - per ac	11,000 lb	6.7 tons	35 tons	70 tons	12 tons

Crop	Cucumbers	Lettuce	Potatoes	Sweet Corn	Watermelons
Variety	Pickmaster	Climax	Kennebec	Sugarloaf Hyb.	Peacock
Number of harvests	4	2	1	1	1
Growing season - days	105	138	129	102	168
Row spacing - in	34	14	34	34	68
Plant spacing - in	12	12	6	8	12
Plant population - per ac	15,000	37,000	30,700	23,000	7,700
Water applied - in	18	17	33	22	39
Nitrogen applied - lb/ac	200	240	240	200	220
Marketable yield - per ac	23 tons	1350 cartons	300 cwt	10 tons	34 tons