

CORN AND SOYBEAN YIELD COMPONENTS GROWN ON A CONTROLLED SUBSURFACE DRAINAGE / IRRIGATION SYSTEM

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ABSTRACT

The influence of plant population on controlled drainage/irrigated corn and soybeans was assessed to determine the optimum plant population for this emerging technology. Corn was planted on 30-inch rows and soybeans were planted on 15-inch rows. Main treatments consisted of irrigated corn having 25,000, 27,000, 29,000, 31,000, and 33,000 seeds /acre and irrigated soybeans having 110,000, 125,000, 140,000, 155,000, and 170,000 seeds per acre. Corn yields averaged 226 bu/acre and there were no significant differences because of populations or spatial distribution over or between the subsurface irrigation lines. Soybeans yields averaged 82 bu/acre and there were no significant differences because of population or field placed with respect to the subsurface irrigation lines

INTRODUCTION

The influence of plant population on controlled drainage/irrigated corn and soybeans was assessed to determine the optimum plant population for this emerging technology. Plant population is an important yield determinant influencing the agronomic yield and the economic yield. As a general rule, a small plant population allows each plant to have more surface and soil space to capture sunlight and obtain soil water and nutrients. In corn, liguleless corn varieties have become common-place, because the leaves are more erect and permit greater light interception and adsorption at higher plant populations. At higher corn populations, key nutrients are applied in greater quantities to provide proper plant nutrient and augment the over-all soil fertility.

Corn does not have the same capacity as soybeans to respond if the initial stand is less than expected. Soybeans may respond to smaller than intended plant populations by exhibiting a greater degree of branching, thus producing more pods per plant. The branching tendency is under hormonal control, which is influenced by light intensity. Greater light intensities promote branching. At higher plant populations, adjacent plants shade each other, reducing the effective light intensity and limiting branching. The final yield is thus a compromise between the average yield per plant and the number of plants per acre.

Economic considerations largely are influenced by seed costs and the observation that branching reduces harvest efficiency by having more pods closer to the soil. Populations may also influence insect and disease pressures, herbicide efficiency, weed shading, water consumption, and a host of other factors.

The Controlled Subsurface Drainage System

The controlled drainage and irrigation system is designed to be entirely gravity powered, except for the well system. The drainage system consists of a series of parallel laterals on 30 ft (10 m) spacings which collect the surplus soil water. The laterals convey the water to collecting lines that transfer the water to a surface ditch or Williams Creek. Drainage control is maintained with a series of stop-log boxes (water control structures) that have precisely placed baffles that control effluent flow (Figures 1).

A series of five wells each supplies approximately 65 gallons/minute (14 m³/hr), for a total of 325 gallons per minute (73.7 m³/hr). The system requires approximately 2 gallons per acre-minute for optimum irrigation performance. Water is conveyed from the wells to the production field using underground 6 inch PVC irrigation pipe. The water is conveyed to the center of the field where manifolds with flow regulators and flow gauges disperse the water to each of four approximately equal land areas (Figure 1). The stop-log boxes control water movement within the system.

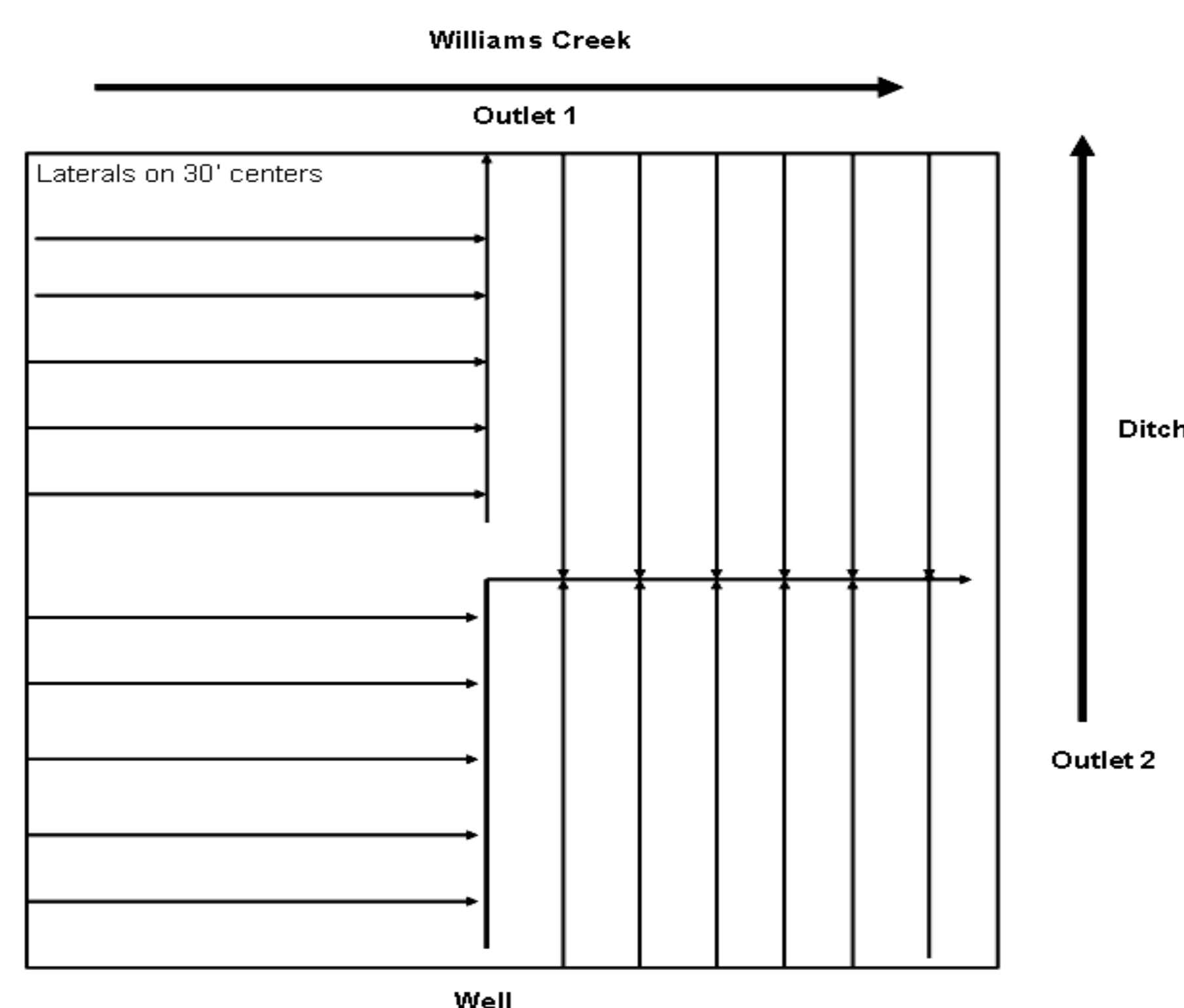


Figure 1 illustration of controlled drainage design

Corn and Soybean Design

Corn and Soybeans were planted in the spring of 2008 30 inch and 15 inch row-spacings, respectively. Main treatments consisted of irrigated corn having (i) 25,000, (ii) 27,000, (iii) 29,000, (iv) 31,000, and (v) 33,000 plants /acre and irrigated soybeans having (i) 110,000, (ii) 125,000, (iii) 140,000, (iv) 155,000, and (v) 170,000 plant populations per acre. All treatments were replicated four times.

Phosphorus and K fertilization was based on grid soil sampling, whereas the N rates were 120 lbs of N as liquid N (32% N-solution) pre-plant, with the remainder of the nitrogen applied approximately four to six weeks post-planting based on a pre-side dress nitrate soil test, stand density and yield goal. Tissue testing and plant biomass accumulation were used to assess nutrient uptake patterns.

Yield estimates were obtained for each replicate to determine: (1) the average yield and (2) the yield difference between areas planted directly over the drainage/irrigation tiles and those planted between the drainage/irrigation tiles.

Results

Table 1. Plant population estimates (Summer 2008)

Corn (<i>Zea mays</i> L.) Intended Population	Corn Estimated Population	Soybeans (<i>Glycine max</i> L.) Intended population	Soybeans Estimated Population
25,000	26,200 ± 350	110,000	86,000 ± 970
27,000	28,400 ± 440	125,000	89,000 ± 19,000
29,000	31,000 ± 450	140,000	110,900 ± 4,900
31,000	32,800 ± 150	155,000	115,000 ± 2,300
33,000	35,500 ± 30	170,000	122,600 ± 3,600

Value ± Confidence Interval (95%)

Corn Harvest Biomass and Nutrient Accumulation Patterns Biomass Accumulation

Plant height and the number of mature leaves per plant were not significantly different because of plant population (Table 2). The greatest plant biomass was associated with the smallest plant population and the least biomass was associated with the highest plant population; however, the differences were not significant.

Table 2. Black layer corn growth and yield components for 2008.

Population plants/acre	Height cm	# Leaves/Plant	Total Biomass g/plant
25,000	342	12.5	367
27,000	338	13.5	344
29,000	338	12.3	276
31,000	337	13.0	325
33,000	336	13.8	250

The percentage biomass distribution among the plant components (ear leaves, leaves (axial leaves or stem leaves), culm, cob, shank, tassel and grain) show that the greatest biomass accumulations in the grain, followed closely by the culm and leaves (Figure 2).

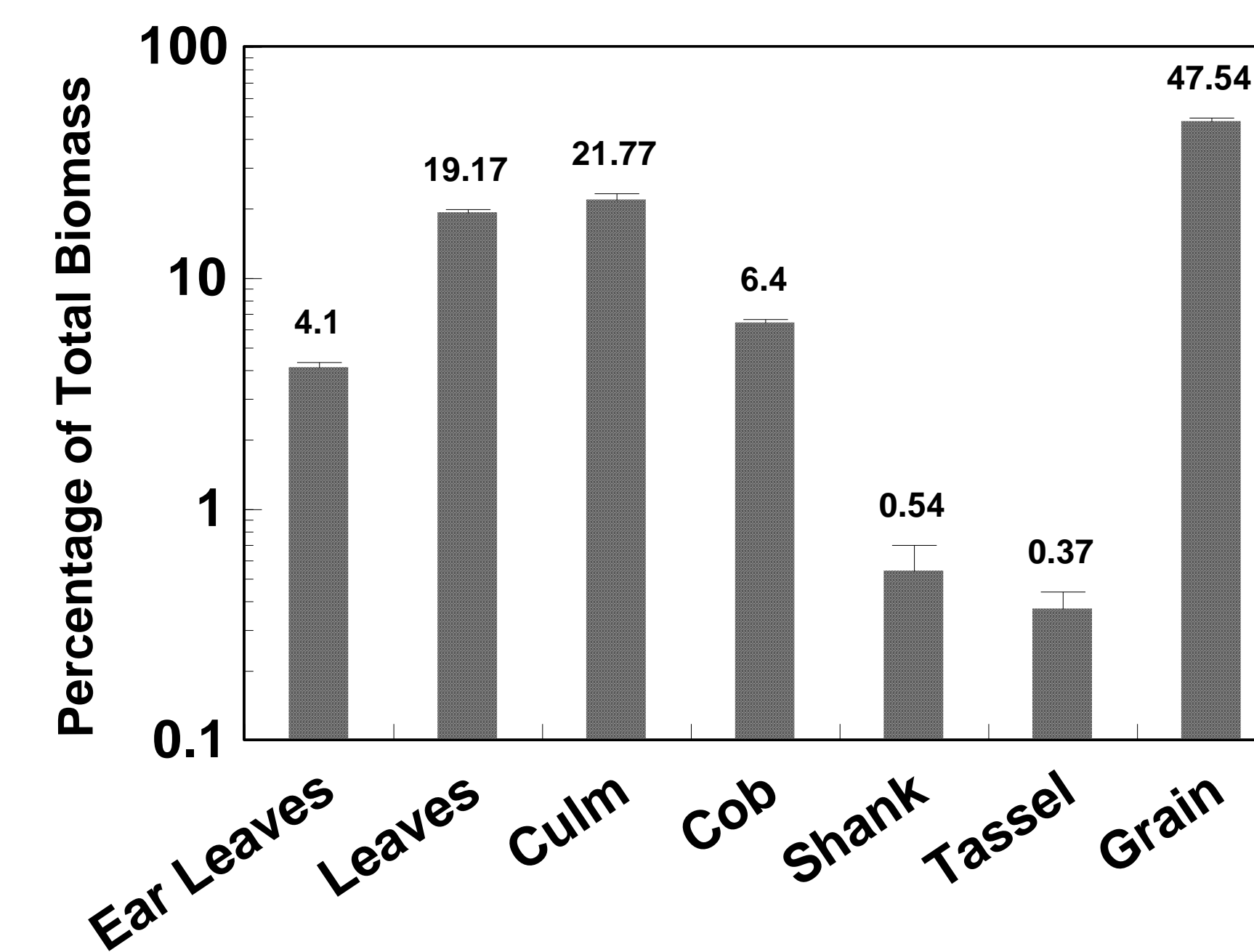


Figure 2. The percentage distribution of biomass components.

Soybean Harvest Biomass and Nutrient Accumulation Patterns Biomass Accumulation at Maturity

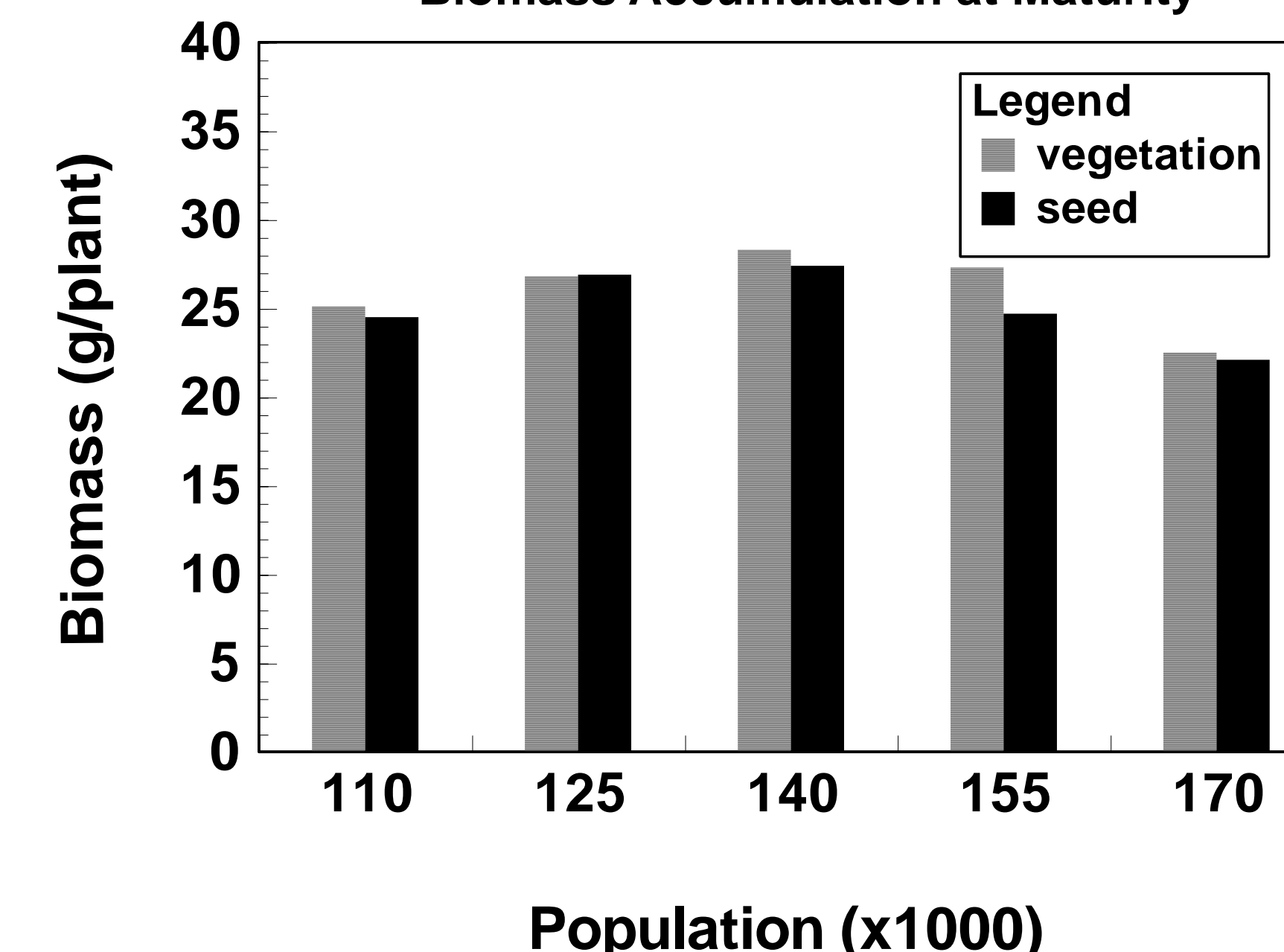


Figure 3. Biomass distribution in the mature soybean plant

Corn Harvest Yield

The yields of corn averaged 226 bu/acre (15.5 % moisture basis) (Table 4). Corn yields from plots between the tile drains/irrigation (Between) averaged 222 bu / acre, whereas the corn yields grown over the tile drains/irrigation (In-line) averaged 230 bu / acre. The yields of the in-line and between were not significantly different. The influence of population on the yield of corn was not significant.

Table 4. Corn yield (bu/acre) between and over irrigation lines

Population	Between	In-Line	Average
25,000	235	220	229
27,000	217	238	227
29,000	220	229	224
31,000	207	227	217
33,000	227	235	232
Mean	222	230	226

No significant differences (P=0.05) involving population or proximity to the irrigation lines

Soybean Harvest Yield

The yield of soybean averaged 82 bu/acre (Table 5). Soybean yields from plots between the tile drains/irrigation (Between) averaged 77 bu / acre, whereas the soybean yields grown over the tile drains/irrigation (In-line) averaged 88 bu / acre. The yields of the in-line and between were not significantly different. The influence of population on the yield of soybean was not significant.

Table 5. Soybean yield (Bu/acre) between and over irrigation lines

Population	Between	In-Line	Average
110,000	74	79	76
125,000	95	95	95
140,000	62	93	74
155,000	73	78	75
170,000	83	94	82
Mean	77	88	82

No significant differences (P=0.05) involving population or proximity to the irrigation lines