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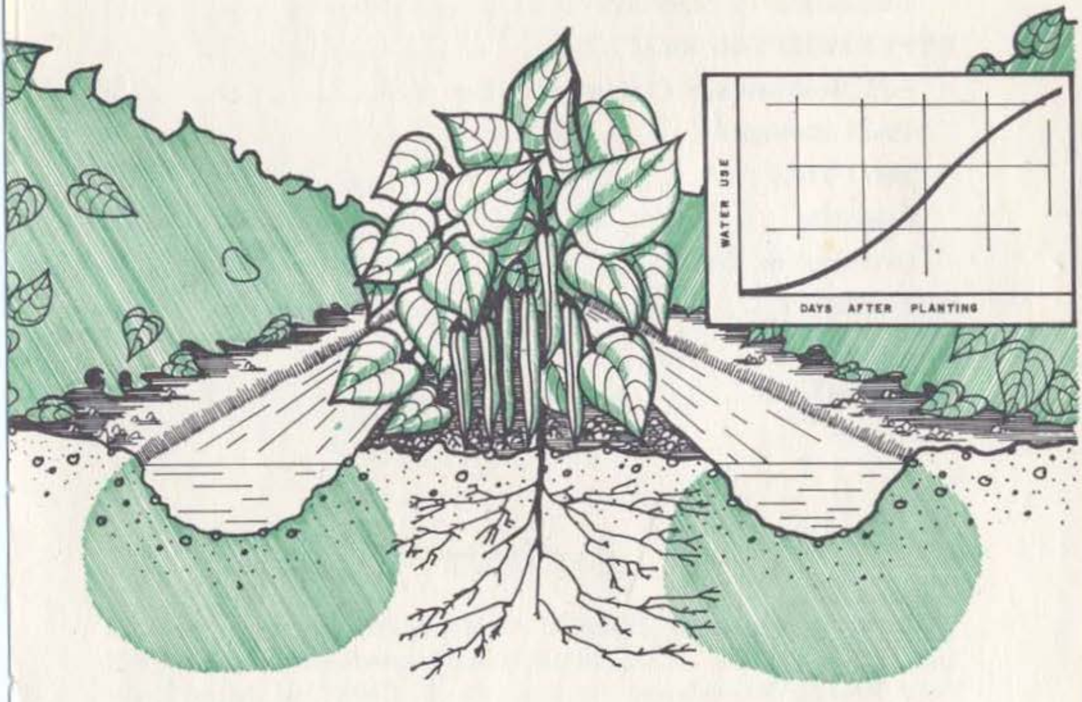
THE INFLUENCE OF SOIL MOISTURE ON SNAP BEAN SEED PRODUCTION



McMaster, LeBaron, Corey, Hawthorn, and Toole

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THE INFLUENCE OF SOIL MOISTURE ON SNAP BEAN SEED PRODUCTION

McMaster, LeBaron, Corey, Hawthorn, and Toole

A research project was initiated in 1955 at the Twin Falls Branch Station, Kimberly, Idaho, to study the effects of soil-moisture levels on snap bean seed production. Reports of the 1955, 1956 and 1957 studies have been published.[11] In the present study, 1959 through 1961, irrigation treatments were set up to maintain different soil-moisture levels in the root zone of the snap bean over two periods of the growing season. The effect of the irrigation treatments was measured on seed yield and plant maturity.

Susceptibility to mechanical injury during threshing and milling of the seed is a major problem with some varieties of snap beans.[1] Cultural practices that cause the seed to resist injury are important as they will increase the yield of usable seed. Measurements were made of the effect of irrigation treatment on the susceptibility of seed to mechanical injury. Results of these studies are presented in this bulletin.

Climatic and Soil Conditions

The climate of the area is characterized by low annual precipitation, a dry atmosphere, hot summers, and a large proportion of sunny days. Most of the annual precipitation occurs as rain or snow during the fall, winter and early spring. The growing season is, therefore, comparatively dry. Table 1 gives the mean temperature and precipitation with departure from normal for the years of this study.

Table 1. Mean monthly summer temperature and precipitation and departures from normal at Twin Falls, Idaho

Month	1959		1960		1961	
	Temperature °F	Precip. inches	Temperature °F	Precip. inches	Temperature °F	Precip. inches
June						
Mean	69.1	0.27	67.6	0.11	71.1	0.16
Departure	+6.1	−0.58	+4.6	−0.74	+8.1	−0.69
July						
Mean	73.5	0.06	76.8	0.01	74.8	0.29
Departure	+1.4	−0.19	+4.7	−0.24	+2.7	+0.04
August						
Mean	69.1	0.05	67.4	0.68	74.8	1.12
Departure	0.0	−0.15	−1.7	+0.48	+5.7	+0.92
September						
Mean	58.3	2.08	64.3	0.14	56.4	1.18
Departure	−2.0	+1.64	+4.0	−0.30	−3.9	+0.74

Three fields on the Twin Falls Branch Station were utilized for this project. The plot soil was classified as a Portneuf silt loam which is characterized by a columnar structure from the surface to a depth of about 15 inches. Below this is a compacted calcareous horizon which is fairly difficult to penetrate with a soil auger but is permeable to water. Before initial farming operations, the top two or three inches consisted of a slightly coherent, light-brown desert mulch which has since lost its identity and become part of the top general horizon. The topography of the area is uniform with a slope of 1.25 percent in the direction of irrigation. Surface and sub-surface drainage was good and the fields well adapted for an experiment involving irrigation.

Procedure

Cultural Practices

Irrigation treatments were tested on two varieties of snap beans, Topcrop and Wade, with May 27 the average planting date. Several days before plantings, the field was irrigated to assure a uniform soil-moisture level for all plots. Bean seed was planted at a rate of 110 pounds per acre with a standard 4-row planter. In 1959 and 1960 the seed was planted in rows 22 inches apart and in 1961 in rows 24 inches apart.* The field was cultivated only when necessary for weed control.

Irrigation

Following the initial cultivation, gated surface irrigation pipe was laid to each replication. Each plot, therefore, received water independently. Four irrigation treatments were arranged in six replications which were 113 feet long and 96 feet wide including buffer rows. Each irrigation plot was split into two sub-plots, one for each variety. Fifty feet of the two middle rows of the sub-plots were harvested for yield. Two buffer rows separated the harvested rows of variety sub-plots and six buffer rows separated the harvested rows of the irrigation plots.

The four irrigation treatments consisted of two moisture levels maintained in the soil over two periods of the growing season. The first period extended from the planting date until the date of full bloom and the second period was from full bloom until the plants had reached maturity. The two soil-moisture levels were obtained by two frequencies of irrigation based on the amount of moisture in the root zone of the soil at the time of water application. The plants were irrigated when the available soil moisture had been 40 percent depleted and 60 percent depleted. These treatments are described as "High" and "Low" soil-moisture levels respectively.

*These two row spacings were used because of a change in standard practice on the Twin Falls Branch Station. Unpublished annual reports of work done at this station report no significant differences in bean yield for a constant seeding rate when planted at these two spacings.

The two soil-moisture levels for two periods of the growing season resulted in four irrigation treatments as follows:

Irrigation Treatment	Soil-Moisture Level	
	Planting to Bloom	Bloom to Maturity
1	High	High
2	High	Low
3	Low	High
4	Low	Low

The high and low soil-moisture levels described here are equivalent to the high and medium levels respectively of a previous publication.[11] Within 24 hours after each irrigation, the moisture level was at field capacity regardless of the irrigation treatment. Furrows were made between all bean rows and water was applied in alternate furrows. The furrow receiving water was alternated at each subsequent irrigation.[12]

Harvest

The plants were cut with a standard 4-row bean cutter. Plots of the two varieties and the different irrigation treatments matured at different rates, therefore, several harvest dates were necessary. The harvest procedure is outlined in Idaho Agricultural Experiment Station Bulletin 336.[11]

Soil Moisture and Consumptive Use Determination

Soil-moisture samples were taken with a soil auger at planting time, before each irrigation, 24 hours after irrigation, and at harvest time for the purpose of determining soil-moisture content and consumptive use under each irrigation treatment. Samples were also taken periodically between irrigations to determine when the available soil moisture in the root zone had depleted to the point requiring irrigation. Samples were taken from several locations in each plot and approximately the same location was used for each sampling period. At each location, samples were taken from the 0-6 inch depth, 6-12 inch depth, and 12-18 inch depth and their soil-moisture content was determined gravimetrically.

The soil-moisture percentage by weight was multiplied by the volume weight of the soil to convert to percentage moisture by volume. The amount of water consumptively used from the area of the root zone sampled was the difference in volumes of water in the samples between irrigations. The actual consumptive use measured between irrigations was extrapolated to include the consumptive use during the irrigation process.

Water in the soil that can be considered available for plant use exists between certain limits. These limits are the field capacity and the wilting point. Moisture in excess of field capacity is soon drained away by gravity and that below the wilting point is held too tightly by the soil particles to be available for plant use. Field capacity and wilting point vary for different soil texture, soil structure, salt content, root distribution and weather conditions.

Field capacity is very difficult to determine accurately.[3] For this study, field capacity was defined as the amount of moisture remaining in the soil following an irrigation and a free drainage period of 24 hours. The average field capacity of the soil was found to be 22 percent water by weight. The wilting point was defined as the amount of moisture remaining in the soil when permanent plant wilting occurred. This limit was found to be 7 percent water by weight.

The plants are very shallow-rooted because of the prevalence of Fusarium root rot in beans grown in the Twin Falls area.[2, 9] The majority of the roots are forced to feed in the top six inches of the soil because of this disease. Such conditions increase the probability that crop yields will be increased when irrigations are applied to maintain a high soil-moisture level.[5]

Maturity Determination

The degree of maturity was evaluated on both bean varieties before the plants were cut. An index number of 1 to 9 was assigned to the plant population of each plot according to its visual appearance. A number of "1" was assigned to the plots with the most immature plants and "9" to those with the most mature plants. The remaining numbers were assigned to plots according to the relative maturity of the plants grown therein. Maturity indexes were made simultaneously by three persons to eliminate, as much as possible, personal bias.

The two varieties, Topcrop and Wade, mature at different dates; Topcrop being the earlier. Maturity was therefore evaluated at different times for each variety. The maturity index of the plots planted to Topcrop variety was determined on August 17, 1960 and August 24, 1961. The index of those planted to Wade variety was determined on August 29, 1960 and August 28, 1961.

Seed Sizing

The seed produced in this study was sized by screening a sample through a nest of screens. The sample for sizing was obtained from the seed threshed by a plot thresher. The screening was done after the seed had been stored for at least 6 weeks to insure uniform moisture content. The screens were of the standard round-hole type and arranged in the following order from top to bottom: 22/64″, 20/64″, 18/64″, 16/64″ screens, and pan. A 200-gram seed sample was tested, and the weight of seed held on each screen was recorded. A fineness modulus was determined by the following formula:

$$FM = \frac{a + b + c + d}{100}$$

where:

FM = fineness modulus
a = percentage weight held on top screen
b = percentage weight held on top two screens
c = percentage weight held on top three screens
d = percentage weight held on top four screens

Artificial Injury of Seed

Seed samples taken from the standard-sized windrow in each plot were artificially injured to determine their susceptibility to thresher injury. A seed injury machine, which produced agitation and treatment similar to that found in a standard bean combine, was used. This machine was described in detail in Idaho Agricultural Experiment Station Bulletin No. 366.[11]

Seed samples were taken from a standard-sized windrow 4 and 8 days after cutting. The seed was hand shelled to minimize mechanical injury. A portion of each sample was then subjected to a simulated threshing operation by the injury machine. The injured and uninjured seed was shipped to Beltsville, Maryland, for germination tests. These were conducted in the Vegetable Seed Investigation Laboratory of the Crops Research Division, Agricultural Research Service, United States Department of Agriculture.

The seed was shipped in bags within cardboard boxes and padded to eliminate possible injury during shipment. On receipt, all seed was stored in sealed cans at 50° F. so that changes would not occur during the short interval before testing.

Germination Methods

Germination tests were made on the two sub-lots of seed from each field plot; one hand-shelled only and the other hand-shelled and artificially injured. One 100-seed sample was used from each sub-lot. These were planted, 100 seeds per flat, in a steam-sterilized muck and sand mixture and held in the greenhouse at a temperature of approximately 68° F. at night and 86° F. during the day.

Evaluation of Seedlings

Two weeks after planting, seedlings were pulled and classified for degree of mechanical injury. Detailed data were recorded not only on major damages to the seed that cause worthless seedlings, thus lowering field-value, but also on less severe injuries that resulted in slight to moderate damage of the field-value seedlings. Previous studies[14] show that seed lots producing seedlings with slight to moderate damage, deteriorate in storage more rapidly than those comparatively free of such minor injuries. A seed was considered to have germinated only if it produced a seedling capable of developing into a plant having field-value.

A seedling capable of producing a normal plant under favorable conditions is termed the plant's field-value.[15] Within this field-value classification, the seedlings were further graded into those having no mechanical damage and those having slight to moderate mechanical damage. For example, of 100 seeds planted, 10 percent might fail to germinate or might produce very severely damaged seedlings and 90 percent would have field-value. Of this 90 percent, 75 percent may show no seedling defect and 15 percent may produce seedlings having slight to moderate mechanical injuries. The 90 percent (field-value) and the 15 percent with slight to moderate injuries are the types of values shown in the tables.

Heavy rains during the harvest season of 1959 prevented normal drying of the plants, and the seeds were heavily infected with fungi which seriously affected germination. Because this condition was not associated with the field conditions under investigation, no germination data were obtained.

Experimental Results

Soil Moisture and Consumptive Use

Total seasonal consumptive use and average daily consumptive use data during the peak use period are shown in Table 2. Figure 1 shows the cumulative consumptive use of plants grown under the high soil-moisture level during both periods of the growing season. This irrigation treatment resulted in the greatest yield of seed and the consumptive use curve resulting from this treatment was used for illustrative purposes.

The plots on which the high soil-moisture level was maintained over both periods of the growing season received an average of eight irrigations per year throughout the 3-year period and used consumptively a total of 11.92 inches per year. An average of 1.4 inches of water was applied to the soil at each irrigation. This amount of water corresponds approximately to 40 percent of the total available moisture-holding capacity of the soil in the root zone of the plant.

Table 2. Irrigation and consumptive use data for Topcrop and Wade snap beans grown under four irrigation treatments at Twin Falls, Idaho, 1959-61

Soil-Moisture Level		Number of Irrigations[1]			Consumptive Use (inches)	
Planting to Bloom	Bloom to Maturity	Before Bloom	After Bloom	Total	Average Daily[2]	Total Seasonal
High	High	4.3	3.7	8.0	.21	11.92
	Low	4.3	1.3	5.7	.21	9.09
Low	High	2.0	3.7	5.7	.22	11.18
	Low	2.0	1.3	3.3	.19	8.18

[1] Irrigation before planting not included.
[2] Average during peak use period.

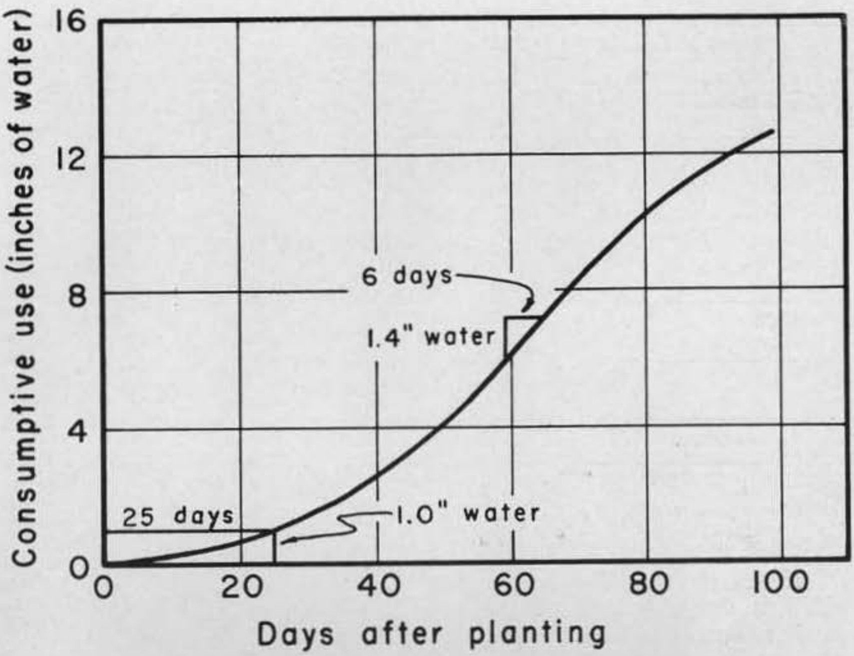

Figure 1. Seasonal consumptive use for snap beans grown under a soil-moisture level varying from field capacity to 60% available water in the root zone.

With this information and the curve from Figure 1, the irrigation interval for all periods of the growing season can be predicted with reasonable accuracy. Assume the total available soil moisture in the root zone was equivalent to 3.50 inches of water and it was desirable to irrigate according to the high soil-moisture treatment. An allowable 1.4 inches of water (40 percent of the total available moisture) would be consumptively used between irrigations. Prior to the first irrigation, when the root zone is shallow, 1 inch of water will represent approximately 40 percent of the total available moisture.

The consumptive use curve indicates that 1 inch of water would be sufficient for approximately the first 25 days of the growing season. At the end of this period, the soil should be irrigated until 1.4 inches of water has been replaced. This amount of water will now last only about 10 days. During the peak use period (50 to 70 days after planting) 1.4 inches of water will last only about 6 days. From 70 days after planting until maturity, daily consumptive use decreases and the irrigation interval can be correspondingly increased.

Plant Maturity

The effect of different irrigation treatments on time of plant maturity was perhaps the most striking and most interesting re-

Table 3. Average maturity index[1] for 1960-61 of two varieties of snap beans grown under four irrigation treatments

Soil-Moisture Level		Variety		Average
Planting to Bloom	Bloom to Maturity	Topcrop	Wade	
		Index Number		
High	High	7.1	6.1	6.6
	Low	8.4	7.4	7.9
Low	High	3.2	1.5	2.4
	Low	4.2	3.2	3.7
High		7.8	6.7	7.2 a[2]
Low		3.7	2.3	3.0 b
	High	5.2	3.8	4.5 b
	Low	6.3	5.3	5.8 a
Average		5.7 a	4.5 b	

[1] Maturity index described in Procedure; the larger the index the more mature the plant.

[2] Values enclosed within lines followed by different letters are significantly different at the 1 percent level and those followed by the same letter are not significantly different on the basis of Duncan's multiple range test.[10]

sult of the entire study. Average maturity indexes for 1960 and 1961 are presented in Table 3. Soil-moisture level early in the growing season affected maturity most significantly. The high soil-moisture level from planting until full bloom resulted in an average maturity index of 7.2, while the low soil-moisture level gave an index of 3.0. Figures 2 and 3 show the appearance of two plots of Topcrop beans prior to harvest, which were grown under a high and low soil-moisture level from planting to full bloom. Results of

Figure 2. Maturity of Topcrop variety was hastened 8 to 14 days by high soil-moisture levels early in the growing season.

this study on snap beans show definitely that maturity is hastened 8 to 14 days by high soil-moisture levels early in the growing season. High soil-moisture levels late in the growing season, however, delayed maturity a few days.

The two varieties reacted similarly to soil-moisture treatments but the Wade matured considerably later. This is not entirely evident in Table 3 because the maturity readings for the two varieties were made on different dates. The plants matured at different rates in different years, but this is to be expected as growing conditions are not exactly duplicated over different growing seasons.

Total Yield

Total yield of snap beans, grown under four irrigation treatments in 3 years, is presented in Table 4. Both varieties reacted the same to the irrigation treatments during the years of this study and Table 4 includes the average yields of these varieties. Topcrop yielded 23.4 cwt. per acre and Wade 21.8 cwt. per acre for all treatments over the 3-year period.

Soil-moisture levels and years had a considerable effect on the total yield of snap bean seed. The high moisture level from planting to bloom resulted in a significant increase in seed yield in 1960 and 1961. In 1959, however, different moisture levels the first part of the season did not result in significantly different yields.

The high soil-moisture level from bloom to maturity resulted in a greater seed yield for all years of the study. It was, in fact,

Figure 3. Compare this photo with that to the left. Low soil-moisture levels from planting until full bloom didn't permit the rapid maturity of high soil-moisture levels.

Table 4. **Total yield of seed (cwt/A) as affected by four irrigation treatments at Twin Falls, Idaho, in 1959, 1960, and 1961. (Average of Topcrop and Wade Varieties)**

Soil-Moisture Level		Yield per Acre			
Planting to Bloom	Bloom to Maturity	1959	1960	1961	Average
		cwt/A	cwt/A	cwt/A	cwt/A
High	High	26.6	24.2	24.8	25.2
	Low	23.2	19.5	22.3	21.7
Low	High	27.4	20.8	23.3	23.8
	Low	23.1	16.3	19.9	19.8
High		24.9 a[1]	21.8 bc	23.6 ab	23.4 a
Low		25.3 a	18.6 d	21.6 c	21.8 b
	High	27.0	22.5	24.1	24.5 a
	Low	23.2	17.9	21.1	20.7 b
Average		25.1 a	20.2 c	22.6 b	

[1] Ibid., page 10 (footnote 2).

during the later part of the season that yield was most greatly affected by soil-moisture variations.

Seed Size

The two varieties, Topcrop and Wade, normally produce small and large seed, respectively. The seed size of each variety was influenced by irrigation frequencies. The average fineness modulus for the seed from each treatment is showwn in Table 5, below. A low soil-moisture level early in the season produced larger seed than the high level. Late in the season, however, the high soil-

Table 5. **Average seed size[1] of two varieties of snap beans as affected by irrigation treatments (average of 1959, 1960, and 1961)**

Soil-moisture level		Variety		
Planting to Bloom	Bloom to Maturity	Topcrop	Wade	Average
		Fineness modulus		
High	High	1.17	1.86	1.51
	Low	0.99	1.79	1.39
Low	High	1.35	1.97	1.66
	Low	1.24	1.92	1.58
High		1.08 d[2]	1.82 b	1.45 b
Low		1.29 c	1.95 a	1.62 a
	High	1.26 c	1.92 a	1.59 a
	Low	1.12 d	1.85 b	1.49 b
Average		1.19 b	1.89 a	

[1] Fineness modulus described in Procedure; a large modulus number indicates a large seed.
[2] Ibid., page 10 (footnote 2).

moisture level produced the largest seed. The irrigation producing the largest seed also resulted in a later maturing plant.

Two significant interactions are evident in Table 5. They are the interaction of soil-moisture level from planting to bloom on variety and that of soil-moisture level from bloom to maturity on variety. These interactions indicate that the seed size from the Topcrop variety is more readily influenced by soil moisture both early and late in the growing season than is the seed from the Wade variety.

Germination Results

Differences due to soil-moisture levels are significant for both years except for slight to moderate injury in 1960 (Table 6). These differences, although significant at the 5-percent level, are small. However, there are general trends. In 1960 irrigation treatment 4 gave the lowest field value for hand-shelled seeds and irrigation treatment 1 the highest after artificial injury. In 1961

Table 6. Interaction of treatment and soil-moisture level on germination of Topcrop and Wade bean seed

	Irrigation Treatment		Seed producing seedlings with	
Year and treatment	Planting to Bloom	Bloom to Maturity	Field-value	Mechanical injuries Slight to moderate
			Percent	Percent
1960:				
Hand shelling	High	High	97.4a[1]	6.7 a
	High	Low	97.3a	4.8 a
	Low	High	97.2ab	5.3 a
	Low	Low	95.7 bc	6.9 a
Artificial injury	High	High	94.8 c	13.3 b
	High	Low	93.1 d	12.3 b
	Low	High	93.2 d	11.8 b
	Low	Low	92.7 d	12.3 b
Averages	High		95.7a	9.3 a
	Low		94.7 b	9.1 a
Averages		High	95.6a	9.3 a
		Low	94.7 b	9.1 a
1961:				
Hand shelling	High	High	99.0a	1.0 a
	High	Low	98.7a	1.3 a
	Low	High	98.0ab	1.4 a
	Low	Low	97.1 b	1.8 a
Artificial injury	High	High	95.6 c	5.9 b
	High	Low	93.9 d	10.3 c
	Low	High	95.0 cd	5.4 b
	Low	Low	94.5 cd	6.3 b
Averages	High		96.8a	4.6 a
	Low		96.2a	3.7 a
Averages		High	96.9a	3.4 a
		Low	96.1 b	4.9 b

[1] Values enclosed within lines followed by different letters are significantly different at the 5 percent level and those followed by the same letter are not significantly different on the basis of Duncan's multiple range test.[10]

irrigation treatment 4 was significantly lower in field-value than all irrigation treatments except 3 for hand-shelled seeds, and irrigation treatment 1 was significantly higher in field-value after artificial injury than irrigation treatment 2 but not the other two treatments. Irrigation treatment 2 was significantly higher in slight to moderate injury than the other treatments.

Table 7. Interaction of variety and irrigation frequency on germination of bean seed

Year and Variety	Irrigation Treatment: Planting to Bloom	Irrigation Treatment: Bloom to Maturity	Seed producing seedlings with: Field-value	Seed producing seedlings with: Mechanical injuries Slight to moderate
			Percent	Percent
1960 Topcrop	High	High	95.8 ab[1]	12.8 b
		Low	95.9 ab	10.5 b
	Low	High	95.3 ab	11.0 b
		Low	93.5 b	11.6 b
Wade	High	High	96.3 a	7.3 a
		Low	94.5 ab	6.5 a
	Low	High	95.1 ab	6.2 a
		Low	94.8 ab	7.6 a
1961 Topcrop	High	High	98.1 a	2.5 ab
		Low	96.9 ab	4.5 ab
	Low	High	97.1 ab	4.6 b
		Low	96.2 b	4.4 ab
Wade	High	High	96.5 ab	4.3 ab
		Low	95.7 b	7.0 c
	Low	High	96.0 b	2.3 a
		Low	95.5 b	3.7 ab

[1] Ibid., page 13 (footnote).

Topcrop showed more slight to moderate injury than Wade in 1960 (Table 7). In 1961 Wade from irrigation treatment 2 showed the most slight to moderate injury. In 1960 the two varieties were not significantly different in field-value except irrigation treatment 4 for Topcrop was significantly lower than irrigation treatment 1 for Wade. The only differences in field-value in 1961 was within the variety Topcrop which showed a lower field-value for irrigation treatment 4 than for irrigation treatment 1.

As expected, artificially injured seeds were always lower in field-value than hand-shelled seeds regardless of period of curing

Table 8. Effect of curing period on susceptibility of seed beans to mechanical injury as indicated by germination

Period cured: Crop year	Period cured: Days	Field-value of seedlings from seed: Hand Shelled	Field-value of seedlings from seed: Artificially Injured	Seedlings with slight to moderate injuries from seed: Hand Shelled	Seedlings with slight to moderate injuries from seed: Artificially Injured
		Percent	Percent	Percent	Percent
1960	4	96.8 a	93.2 b[1]	5.9 a	10.7 b
	8	97.0 a	93.8 b	5.9 a	14.1 c
1961	4	98.2 a	95.8 b	1.4 a	5.0 b
	8	98.2 a	93.8 c	1.4 a	8.9 c

[1] Ibid., page 13 (footnote).

(Table 8). For artificially injured seeds, 8-day curing caused significantly lower field-values in 1961 and in both years caused more slight to moderate injury.

The two varieties behaved in a similar manner in respect to periods of curing (Table 9). There were no differences in field-value between varieties for either year. Eight-day curing caused more slight to moderate injury in both varieties for both years except for Wade in 1960.

Table 9. Effect of curing period on germination of two varieties of bean seed

Period cured		Field-value of seedlings of		Seedlings with slight to moderate injuries of	
Crop year	Days	Topcrop	Wade	Topcrop	Wade
		Percent	Percent	Percent	Percent
1960	4	95.1 a	94.8 a[1]	10.4 b	6.3 a
	8	95.1 a	95.6 a	12.5 c	7.5 a
1961	4	97.5 a	96.5 a	3.2 a	3.2 a
	8	96.7 a	95.3 a	4.8 b	5.5 b

[1] Ibid., page 13 (footnote).

Hand-shelled seeds of Topcrop showed more slight to moderate injury than Wade in 1960 (Table 10). In comparison with hand-shelled seeds, artificial injury caused a greater increase in slight to moderate injury for Wade than for Topcrop.

Table 10. Interaction of treatment and variety as indicated by germination

Crop year and Treatment	Field-value of seedlings of		Seedlings with slight to moderate injuries of	
	Topcrop	Wade	Topcrop	Wade
	Percent	Percent	Percent	Percent
1960 Hand Shelling	96.9 a	96.9 a[1]	8.5 b	3.3 a
Artificial Injury	93.4 b	93.5 b	14.4 d	10.4 c
1961 Hand Shelling	97.8 a	98.7 a	1.8 a	1.0 a
Artificial Injury	96.4 b	93.1 c	6.2 b	7.7 c

[1] Ibid., page 13 (footnote).

Discussion

Two soil-moisture levels were maintained in the soil on which a bean crop was grown at Twin Falls, Idaho. The moisture levels were maintained over two periods of the growing season, from planting to full bloom and from full bloom to plant maturity. The crop on which the soil-moisture treatments were tested was two varieties of snap beans, Topcrop and Wade. Different soil-moisture treatments were obtained by varying the irrigation application frequency. The soil-moisture level was allowed to vary from field capacity (after irrigation) to approximately 60 percent and 40 percent of field capacity (prior to the next irrigation). The most notable effect of irrigation treatments was on the maturity of the plants. Adequate early irrigation resulted in early maturing plants and, 2 years out of 3 produced a greater total yield of seed. Katten[8] also has shown in a 1-year study, that soil-moisture levels prior to plant blooming did not affect the yield of fresh pods from the Wade variety of snap beans. Since the high soil-moisture level gave a higher yield of seed it appears that this is the treatment that should be recommended with respect to seed yield. This is important in areas of short growing seasons as an early maturing crop may be the only successful one. Not all vegetable plants react the same to soil-moisture treatments. It has been shown by Hawthorn[6] and Hawthorn *et al.*[7] that the maturity date of carrot and lettuce plants grown for seed was delayed by high soil-moisture levels throughout the growing season.

Previous work[4,8,13] has shown that excessive moisture stress from blooming to harvest will reduce yields of pods and dry beans considerably. In some cases[4,13] it has also shown that low moisture levels from planting to blooming will decrease yields. Results of the work at Twin Falls indicate a high soil moisture from planting to harvest will give the highest yields of seed; and that seed yields are more easily influenced by the late season soil-moisture levels.

In the studies previously reported, there were no significant differences in germination values between the high and medium irrigations. In the present studies, when these two moisture levels were maintained from planting to bloom and from bloom to maturity, differences in field-value and in slight to moderate injury included in field-value were significant, although not of a magnitude to be commercially important. However, these differences show trends that may indicate principles of irrigation. High moisture from bloom to maturity tend to give slightly higher field-value than low moisture. Although the soil moisture from planting to bloom in general has less influence on germination than from bloom to maturity, the high moisture tends to result in higher field-values.

Also, as previously reported, the 8-day period of field curing resulted in more seedlings with slight to moderate injury than the 4-day curing. Both varieties responded alike to period of curing. curing.

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Findings of this Snap Bean Irrigation Project

1. Time of maturity for snap beans grown for seed can be hastened by proper irrigation practices. High soil-moisture levels early in the growing season caused an early maturing plant while usually increasing yield of seed. Low soil-moisture levels late in the season tended to force the plants to maturity at the expense of a decrease in seed yield.

2. Consumptive use was decreased as the time between irrigations was allowed to increase. It was not directly proportional to the number of irrigations but more dependent on the soil-moisture level maintained in the root zone.

3. A low soil-moisture level early in the season and a high soil-moisture level late in the season resulted in larger seed. These irrigation treatments also resulted in the most delayed maturity of the plants.

4. Differences in germination were not great, although shown to be significant at the 5-percent level. Wade and Topcrop were not strikingly different in response to the various treatments. Germination tended to be higher for seeds, especially those artificially injured, grown under a high soil-moisture level for the entire growing season.