Yield of Snap Beans (*Phaseolus vulgaris* L.) as Influenced by 5-Chloro, 2-Thenyl, Tri-n-Butyl-Phosphoniumchloride[1]

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Abstract. **A single foliar spray of 25 or 28 ppm 5-chloro,2-thenyl, tri-n-butyl-phosphoniumchloride (CTBP) when the first flowers opened increased yields of 2 cultivars planted in late summer and 2 of 4 cultivars planted in late spring, 1970. Yield increases were due to more pods. In general, CTBP treatments that increased yields did not influence seed and fiber development, shear press values, and color of 4-sieve and 5-sieve pods that were canned. Also, Ca, Mg, P, and K levels of 4-sieve, deseeded 5-sieve, and seeds from 5-sieve pods were not influenced by CTBP treatments.**

Several workers have tried to increase snap bean yields by using growth substances with varying degrees of success. Wittwer and Murneek (4) found that β-naphthoxyacetic acid, α-napthaleneacetic acid, and β-indolebutric acid were not consistently effective in increasing yields. Plants treated with p-chlorophenoxyacetic acid had higher yields but much of the increase was due to larger pods (4). In another study (3), gibberellin treated plants required support and did not produce more than untreated plants. More recently, Wort (5) has reported that naphthenates increased yields 20% but the increase was due to pod size. Additional work (2) has shown that plants treated with naphthenates were larger and produced more pods at higher temperatures and light intensities.

A new growth substance, CTBP, distributed as Chemagro 8728[2] was applied to late spring and late summer crops of snap beans in 1970 to determine if it would increase yields of high quality snap beans grown for processing.

'Galagreen', 'Bush Blue Lake-112' (BBL-112), 'Bush Blue Lake-290' (BBL-290) and 'NCX-773' were planted May 6. A 4 x 4 latin square design was utilized for each cultivar. Single row plots were 20 ft long and the middle 15 ft were harvested. Plant stand was about 10 plants per ft in rows 39 inches wide. For the late summer crop, 'Early Gallatin' and 'NCX-773' were planted July 28. Plot design and the same recommended cultural practices as for the late spring crop were followed. CTBP treatments were applied when the first flowers opened. Plants were sprayed until runoff. The average daily temperatures for a 10 day period following CTBP sprays were 80° and 78°F for the late spring and late summer plantings, respectively. See Table 1 for treatments. Tween 20, a surfactant, was added to all treatments at the rate of 100 ppm in the spring and 150 ppm in the fall. Plants were pulled by hand and all pods removed to simulate a once-over mechanical harvest. In the late spring planting, plants from all treatments of a given cultivar were harvested 6 days after the appearance of 5-sieve pods in the control plots, and in the late summer planting, 5 days after the appearance of 5-sieve pods in control plots.

Yields were recorded before and after grading into sieve sizes. To prevent yield discrepancies due to treatments advancing maturities (large pods) or retarding maturity (small pods), yield data are reported as equivalent yields where small pods, sieve sizes 1-4, were assigned a value of 1 and large pods, sieve sizes 5 and over, a value of 1/2 (1).

Samples of 4-sieve, deseeded 5-sieve pods, and seeds of 5-sieve pods from the late summer crop were dried for mineral analysis by standard methods with an atomic absorption spectrophotometer. Also, composite samples of 4-sieve and 5-sieve beans from all replications of a given treatment and cultivar were snipped and cut into 1 1/2 inch cuts for canning. The 3 or 4 can composite samples were analyzed for seed and fiber development, resistance to shear, and color.

Analyses of variance were performed on equivalent yields, percentage of large pods, plant ht and width, and K, Mg, Ca and P levels of pods. For the sake of brevity, data significant at the 5% level are shown in tabular form while non-significant data are reported in the text.

In the spring planting, 'BBL-290' and 'NCX-773' plants treated with a foliar spray of 25 ppm CTBP produced more than untreated plants (Table 1). Also, 'NCX-773' plants treated with 12 ppm had higher yields and 'BBL-290' tended to have higher yields. Yield and quality data from 'Galagreen' and 'BBL-122' are not shown since CTBP tended to increase yields only.

The 6 ppm treatment was discontinued in the fall since it did not increase yields during the spring tests. 'NCX-773' and 'Early Gallatin' treated with 28 ppm CTBP in the fall had higher yields than untreated plants (Table 1). Plants treated with 14 or 44 ppm CTBP had a slight tendency toward higher yields than controls. The results of these tests indicates that a 25-28 ppm concn should increase yields if a cultivar responds to CTBP.

'BBL-290' was the only cultivar where the 25 ppm treatment increased

Table 1. Snap bean yields, sieve sizes, and plant ht as influenced by CTBP, 1970.

Season and cultivar	CTBP (ppm)	Equivalent[1] yields (tons/acre)	% total[3] yield ≥ 5 sieve size	Plant[4] ht (inches)
Late spring				
BBL-290	0	5.2 a[2]	43 a	11.8 a
	6	5.1 a	42 a	11.9 a
	12	6.1 ab	38 ab	12.0 a
	25	6.3 b	28 b	11.8 a
NCX-773	0	4.1 a	51 a	16.3 a
	6	4.4 ab	52 a	16.3 a
	12	4.7 bc	56 a	15.8 a
	25	4.9 c	55 a	15.9 a
Late summer				
NCX-773	0	4.5 a	38 a	16.0 b
	14	4.8 a	42 a	15.4 ab
	28	5.3 b	33 a	14.8 a
	44	5.0 ab	39 a	14.8 a
Early Gallatin	0	4.4 a	40 a	15.5 b
	14	4.8 ab	40 a	15.0 b
	28	5.2 b	41 a	14.2 ab
	44	4.8 ab	41 a	13.2 a

[1] Equivalent yields were obtained by assigning sieve 4 (small pods) and under a value of 1; sieve 5 and over (large pods) a value of ½.

[2] Means within a column, for a given cultivar and season, having a letter or letters in common are not significantly different at the 5% level (Duncan's Multiple Range test).

[3] Figures represent percentage of total yield that graded 5-sieve and over.

[4] Measurements made prior to harvest.

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[2] Appreciation is expressed to Dr. Elmo Shipp, Chemagro Chemical Corp. for donating the Chemagro 8728 used in these studies.

yields as well as the percentage of small pods (Table 1). Higher yields for all cultivars were due to plants producing more pods since the wt of large pods, 5-sieve and over, were the same or less than controls (Table 1). Four-sieve and 5-sieve pods from treated plants were of the same length as pods from untreated plants.

CTBP treatments did not influence plant ht at harvest in the late spring tests (Table 1). In the late summer tests, 'NCX-773' plants treated with 28 or 44 ppm CTBP and 'Early Gallatin' plants treated with 44 ppm were shorter than untreated plants. None of the treatments influenced plant width at harvest.

In the spring, 2 days after CTBP treatments, some of the half expanded trifoliates of all cultivars that were treated with 25 ppm showed a marginal chlorosis. This symptom gradually disappeared during the next 12 days. During the fall, this symptom was not observed on any of the treatments, including some observational plots treated with 77 ppm CTBP.

In general, CTBP treatments did not influence seed and fiber development, color, and shear press value of canned 4-sieve and 5-sieve snap beans. Also, none of the treatments affected the K, Mg, Ca, and P levels of 4-sieve pods, deseeded 5-sieve pods, and seeds from 5-sieve pods of late summer planted 'NCX-773' and 'Early Gallatin'.

Additional tests under a wide range of growing conditions are needed to determine if CTBP can increase yields of snap beans by increasing the no. of pods. Also, it has to be ascertained if some cultivars consistently respond better to CTBP than others.

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Instant Waxing by Use of the *arg* Gene as a Means to Improve Wax Beans[1]

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Abstract. **The *arg y* gene combination in beans (*Phaseolus vulgaris* L.) normally produces white pods, but pods with desirable yellow wax bean color can be developed by selection within this genotype for high cartoenoid levels and low chlorophyll levels. These pods exhibit acceptable yellow color at all stages of growth, unlike normal wax pods which are green initially but turn yellow in color only as they approach full size.**

Waxing or loss of chlorophyll with pod maturation in beans was reported by Emerson (3) in 1902 and is conditioned by a single recessive gene pair, *yy*. Currence reported that the recessive gene *s* in combination with *y* resulted in a white podded bean (1). Because *s* had prior use by Malinowski (5), it was renamed *arg* (silver) by Lamprecht (4). *Y arg* produces a silver or greenish grey pod as in the cultivar 'Crystal White Wax' whereas *y Arg* results in a normal yellow wax pod. Apparently there are no white podded cultivars in commerce. However, our recent studies on the differences in pod chlorophyll and carotenoid contents (2) indicated that this gene offered new possibilities within the accepted yellow podded or "wax bean" class.

We first observed the white pod character in a single F_2 segregate from the cross 'Earliwax' x Lamprecht's Line 116. Study of progeny from crosses between white podded plants (presumably *y y arg arg*) and several wax cultivars (Table 1) indicated the mode of inheritance reported by Currence (1). However, our interest from the standpoint of breeding was in the very small pods (pin beans), which when observed the day after flowering, were white or pale yellow. This "instant waxing", contrasts with the slow yellowing seen in normal wax beans where the pin beans are deep green and the young pods do not turn yellow until near pod maturity (Fig. 1 and 2). The development of instant waxing cultivars would permit harvesting earlier than normal because there would be no green pods to discard. Instant waxing would reduce the genetic and environmentally induced color variability seen at maturity in normal wax beans.

The heritability of both chlorophyll and carotenoid intensity in wax beans is about 50% for each character and they are inherited independently (2). Pod color is determined by the major genes, *y* and *arg*, and by several minor genes acting independently. Therefore it seemed likely that by backcrossing a yellow instant-wax bean could be obtained by selecting for those minor genes which increase carotenoids and against those which increase chlorophyll.

We found some instant-wax segregates from backcrosses to wax beans of good horticultural type produced pale green juvenile pods (but not as green as normal juvenile wax pods). This pale green color disappeared with maturity as in normal-wax beans. Other segregates however did exhibit the desired yellow color, both in the young and in the mature pods. By selection in large populations for minor genes for increased carotenoids and against minor genes for increased chlorophyll development it was possible

Table 1. Segregation at *y* and *arg* loci in beans.

Parents	Genotype and phenotype of parents		Segregation classes			Expected ratio	X^2	P
			White	Normal wax	Green			
			yyargarg	*yyArg–*	*Y–Arg–*			
OSU58 x	*YYArgArg* x *yyargarg*	Obs.	5	15	57	1:3:12	.039	.99
27-17 F_2	green x white	Exp.	4.8	14.4	57.8			
Midas x	*yyArgArg* x *yyargarg*	Obs.	14	61	0	1:3	1.600	.60
27-16 F_2	yellow x white	Exp.	18.7	56.3	0			
KW x	*yyArgArg* x *yyargarg*	Obs.	9	25	0	1:3	.040	.95
54-4 F_2	yellow x white	Exp.	8.5	25.5	0			
W21 x	*yyArgArg* x *yyargarg*	Obs.	35	106	0	1:3	.002	.99
27-19 F_2	yellow x white	Exp.	35.3	105.7	0			
White x	*yyargarg* x *yyArgArg*	Obs.	0	55	0	0:8	.000	1.00
Wax BCF_1	white x yellow	Exp.	0	55	0			

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