EFFECT OF TRIIODOBENZOIC ACID (TIBA) ON THE GROWTH HABIT AND YIELD OF SOYBEAN

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ABSTRACT

2,3,5 triiodobenzoic acid was applied to soybeans at flowering at 37 g/ha in one year and 19, 28 and 47 g/ha in 3 further years. Crop height was reduced in each year by 3 to 20% through shortening of the internodes with the greatest height reduction at the 47 g/ha rate. In two years, with water supply unlimiting to crop growth, yields of 3.0 and 2.3 t/ha were improved 16 and 20% respectively with TIBA applied at an optimum rate of 19 g/ha. Where crop growth was limited by water supply at flowering a yield of 3.0 t/ha was reduced 13% by TIBA at 28 g/ha and 27% at 47 g/ha. Where water supply limited crop growth in the flowering and post flowering period, yield was low (1.4 t/ha) but unaffected by TIBA. TIBA increased yields in both narrow row (15 cm), high density (40pl/m^2) and wide row (30 cm), low density (20pl/m^2) plantings in one year when crop growth was extensive but only at the high density, narrow row planting in the other year when crop growth was 20% less. It was concluded that the yield of soybean crops, showing normal to above normal growth vigour at flowering, could reasonably be expected to be increased 15% by TIBA application at 19 g/ha.

INTRODUCTION

The soybean varieties so far found to be adapted to production in the northern North Island are of indeterminate growth habit and as such continue to make vegetative growth after flowering commences. This characteristic allows for a prolonged flowering period, improving the chance of a good pod set in a crop where flower set is sensitive to weather conditions and the extent of flower shedding high. At the same time, continued vegetative growth competes with flower setting and Galston (1947) has shown that the application of the antiauxin 2,3,5 triiodebenzoic acid (TIBA) will restrict vegetative growth and enhance flowering. Field studies (Greer and Anderson, 1965; Bauer *et al.,* 1969) show the greatest effect is achieved with TIBA by application at the commencement of flowering. Crop height is reduced through shortening of the internodes and harvest lodging may be reduced. The top leaves of the crop are reduced in size and given a more vertical orientation permitting better light penetration. Higher yields result from an increase in pod numbers and seed numbers though seed size is reduced (Burton and Curley, 1966; Hicks *et al.,* 1967; Wax and Pendleton, 1968). Yield increases of up to 20% have been achieved but their occurrence is unpredictable. Preflowering weather conditions influence the degree of response (Hume *et al.,* 1972) with conditions promoting vigorous vegetative development, higher than normal temperatures and rainfall, giving the best response. Rate of application for the best yield response has varied from 30 g/ha (Greer and Anderson, 1965) to 60 g/ha (Bauer *et al.,* 1969 and Hume *et al.,* 1972). Commercial application is recommended at 28 to 47 g/ha.

Soybeans in New Zealand can have extensive vegetative growth while pod numbers are low. These factors, together with the reoccurrence of flowering following a dry-wet sequence of weather which can result in a high proportion of immature pods at harvest, stimulated the testing of TIBA on the crop.

MATERIALS AND METHODS

Four trials with TIBA were run in the period 1970 to 1976 on well fertilised, free draining, sandy loam soil sites on the Rukuhia farm. TIBA as Regim 8 (13.3% 2,3,5 triiodobenzoic acid) was applied at the 10% flowering stage in 300 l/ha water as a broadcast spray over the rows. Adjacent plots were protected from drift by polythene sheet. The crop management factors involved in each year were:

1970: Cultivars Acme, Comet and Lindarin were sown 13, 26 November and 11 December in 25, 50 and 75 cm rows at densities of 80, 40 and 27 plants/m^2 respectively. TIBA was applied at 0 and 37 g/ha to 4.5 x 4.5 m^2 sub-plots on each of the four replicates of the 27 treatments.

1973: Cultivar Amsoy was established at 20 plants/m^2 in 60 cm rows. In a randomised block trial with 4 replicates, TIBA was applied at 0,19,28 and 47 g/ha to 4, 6 m rows of the 6 row plots.

1974: Cultivar Amsoy was established in 15 and 30 cm rows at densities of 42 and 27 plants/m^2 respectively. TIBA was applied as in 1973.

1975: Cultivar Amsoy was established in 15 and 30 cm rows at densities of 22 and 37 plants/m^2. TIBA rates as in 1973, were incorporated in a 4 replicate randomised block design.

At harvest, yield at 12% moisture content were determined from a measured area of crop. Plant characteristics, height, node number, pod number and pod distribution were recorded from a sample of 5 plants per plot.

RESULTS AND DISCUSSION

Crop Height

Mature crop height was reduced by TIBA in all years (Table 1). Crop growth was restricted naturally in the 1970 plantings by water stress from flowering to maturity and the reduction in height, at the single rate of 37 g/ha, was small (3%). However, a similar reduction in height occurred irrespective of the cultivar, sowing date or crop density used. Under more favourable moisture conditions, crop growth in the 1973, 1974 and 1975 plantings was 30% greater and the height reduction due to TIBA larger than in 1970. The extent of crop height reduction depended on the rate of TIBA applied but was independent of the plant density, row spacing treatments used. Response to rates of TIBA was not significantly different amongst years. Height reductions averaged 5, 7 and 12% for the 19, 28 and 47 g/ha rates respectively.

TABLE 1: Yield and plant characteristics with rates of TIBA in four years.

	TIBA rate g/ha	Year Planted 1970	1973	1974	1975
Yield (t/ha)	0	1.4 a	3.0 aA	3.0 bA	2.3 bcB
	19		2.8 abA	3.5 aA	2.4 abAB
	28		2.6 bAB	3.5 aA	2.6 aA
	37	1.3 a			
	47		2.2 cB	2.9 bA	2.2 cB
Height (cm)	0	70 aA	86 aA	103 aA	84 aA
	19		83 aAB	93 bA	81 abAB
	28		80 aAB	97 abA	77 bcAB
	37	67 bA			
	47		69 bB	95 abA	75 cB
Node number	0		13.4 aA	15.7 a	15.1 aA
	19		12.6 abAB	15.0 a	14.6 aAB
	28		12.6 abAB	16.2 a	13.9 bB
	37				
	47		11.6 bB	16.2 a	13.6 bB
Pod number	0	25 a	27 abA	31 aA	29 a
	19		25 bA	29 abA	29 a
	28		34 abA	33 aA	27 a
	37	25 a			
	47		38 aA	25 bA	28 a

Most of the reduction in plant height was due to a decrease in the internode length though small, but significant, reductions in node number did occur at the 47 g/ha rate in two years and at the 28 g/ha rate in one year. Reduction in crop height had no visible effect on crop lodging but crop lodging throughout the trials was low.

Yield

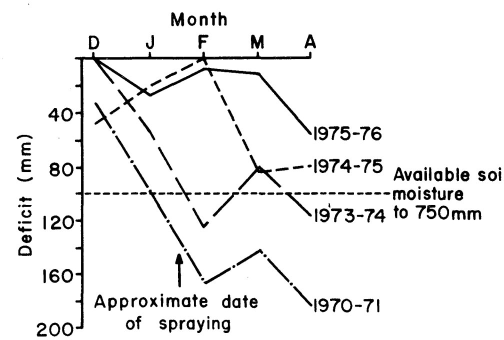
Bean yield was increased by TIBA in two years out of the four, reduced in one and was unaffected in the remaining year (Table 1).

Whether a yield response was obtained related primarily to the extent of vegetative growth of the crop and, in turn, to the pattern of the seasonal moisture supply. In those years with normal to above normal spring-early summer temperatures, moisture supply was the predominant factor determining differences in the extent of plant growth (Table 2 and Fig. 1.). Yield was increased only in the 1974 and 1975 plantings where there was no lack of moisture for plant growth throughout the season. With crop growth limited by water stress in the flowering and post flowering periods in the 1970 planting, crop yield was less than in other years and unaffected by TIBA application. Where, for the 1973 planting, moisture was restricted at flowering and until 17 days later when irrigation was applied, crop yield was reduced by the two higher rates of TIBA used. The extent of the height reduction (20%) and the reduction in node number brought about by the high rate of TIBA in 1973 were similar to those under which Bauer *et al.* (1969) observed yield reduction.

TABLE 2: Differences from normal in accumulated degree days in pre- and post- flowering periods for trial years.

Period	Year of Planting 1970	1970	1974	1975
Dec, Jan.	+26	+47	+77	−20
Feb, Mar.	−57	+86	+59	−53

Figure 1: Accumulated moisture deficit in 4 seasons.



The various sets of moisture conditions under which yield responses were observed did not include preflowering water stress followed by adequate water supply. Nevertheless, the pattern of yield response implied that yield increases will only be achieved where crop growth during the preflowering and flowering periods is unrestricted by water supply. The dual conditions of adequate water and normal to above normal preflowering temperatures under which yield increases were obtained with TIBA agree with those considered necessary by Hume *et al* (1972) to consistently give a yield response.

Reasons for the yield increases obtained with TIBA were not apparent. Changes in pod number were inconsistent with changes in yield (Table 1) and seed weight, measured in the 1975 planting when yield was increased, was unaffected by TIBA. More intensive sampling of pod number and data on seed per pods appear to be necessary to analyse the changes.

Rate of TIBA and crop density

The extent of the yield increase depended on the rate of TIBA used and, in one year, on the density and planting pattern of the crop (Table 3).

The optimum rate of use was well defined at 19 g/ha. Use of the 28 g/ha rate, the lowest commercially recommended rate in the USA, was not justified. Though giving similar yields under favourable growing conditions, the higher rate reduced yield in the 1973 planting when growth conditions at, or soon after, application were adverse.

TABLE 3: Yield in relation to plant spacing and rate of TIBA in two years.

Year Planted	TIBA rate (g/ha)	Plant Pattern 20/15*	40/15	20/30	40/30
	0	2.3 ab	2.3 b	2.3 a	2.5 ab
	19	2.3 ab	3.0 a	2.3 a	2.1 b
1975	28	2.6 a	3.2 a	2.3 a	2.2 b
	47	1.9 b	2.4 b	2.0 a	2.6 a
	0		3.2 ab	2.8 b	
	19		3.4 a	3.6 a	
1974	28		3.3 a	3.6 a	
	47		2.8 b	3.0 b	

* Plants /m^2 and row width (cm) respectively.

The importance of crop density and planting pattern in the yield response was not well defined with inconsistent results amongst years. Similar yield increases were obtained in the 1974 plantings regardless of whether low density, wide row or high density, narrow row plantings were used. In the 1975 plantings, however, TIBA increased yield only where the high density, narrow row planting was used. Differences in response appear to relate again to the extent of crop growth in each year. Seasonal temperatures were higher for the 1974 than for the 1975 plantings and growth was more extensive with mature crop height 20% greater. With the more extensive crop growth, yield was not increased with the higher plant density but did respond to TIBA even at the low plant density. Where crop growth was less vigorous, the use of high density or narrow row plantings in themselves increased yield and the benefit of TIBA was realised only at the high density, narrow row plantings. The inference is that TIBA is most effective in increasing yield where interplant competition is high though the lack of response to the high density planting in wide rows made in 1975 does not conform.

CONCLUSION

Where growth conditions are such that they promote normal to above normal vegetative growth of the soybean the application of TIBA at 19 g/ha can be reasonably expected to reduce crop height by 5% and increase yield by 15%. Wider testing of TIBA on other cultivars is desirable.

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