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EFFECT OF SPRAYS OF PLANT GROWTH REGULATOR HYDROGEN CYANAMIDE (DORMEX) ON YIELD OF TEA

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A series of trials were conducted in the high, mid and low elevations to evaluate the effect of sprays of the growth regulator, hydrogen cyanamide (Dormex) on yield of tea. Dormex was sprayed onto pruned frames of tea on the day of pruning and on the third or seventh day after pruning at 0, 1% (5 l Dormex in 500 l water ha^{-1}) and 2% concentrations. Both concentrations enhanced bud burst and tipping weight; overall, yield was increased by about 15 to 20% in the year of prune; there was no depression of yield in the second year. Dormex at 1% concentration sprayed within 7 days of pruning increases yield in the year of pruning.

INTRODUCTION

In Sri Lanka tea is pruned under widely varying climatic conditions associated with different parts of the island. Pruning is undertaken when the yield commences to show a downward trend at which time most buds become dormant. The pruning operation removes most of the leaf bearing branches and new growth in the ensuing cycle arises from the activity of the dormant buds on the pruned branches. In general, it takes about four weeks for bud break after pruning. Tipping of newly formed shoots is done to obtain a level plucking surface and is carried out around 90 days from prune depending on elevation. Thus in the year of prune there is a loss of crop on an average of about 20% which is primarily due to the time taken for recovery and for the new shoots to form a full cover in order to realise their true potential. Recovery from pruning depends on the severity of prune, jat of tea, level of reserves in the root system, etc; the more severe the prune, the longer the time taken for bud emergence.

Dormancy refers to the temporary suspension of visible growth as in seeds and buds. The hypothesis that bud dormancy is induced by endogenous growth inhibitors and that promoters release buds from dormancy was first advanced by Hemberg (1949 *a, b*). Exogenous application of gibberellic acid has been shown to break bud dormancy in tea (Kulasegaram, 1969; Kulasegaram and Kathiravetpillai, 1972). In the recent past several formulations of plant growth regulators have been tried out to study their effect on the yield of tea. The growth regulator hydrogen cyanamide has been found to be a potent agent for inducing uniform bud break in pruned vineyards (Shikhamany and Reddy, 1989; Zelleke and Kliewer, 1989) and is being used extensively on a variety of horticultural crops. Hydrogen cyanamide (H_2CN_2) is a soluble hydrolysis product of calcium cyanamide ($CaCN_2$) marketed under the trade name 'Dormex'.

This paper reports the results of experiments carried out to evaluate the efficacy of spraying hydrogen cyanamide on yield of tea.

MATERIALS AND METHODS

A number of trials were conducted at different elevational ranges in which three concentrations of hydrogen cyanamide or 'Dormex' (containing 49% active ingredient) at 0, 1% (1 l Dormex in 100 l water, i.e. 5 l in 500 l water ha^{-1}) and 2% were sprayed after pruning (at 45 cm from ground level) onto the pruned frames. The bushes were drenched thoroughly using knapsack sprayers. Bud counts involved counting of all visible buds. Tipping weights were also recorded.

Experiment 1. Up-country (1382 m amsl) - Field No. 7, St. Coombs Estate, Talawakele

Type of tea :	Clones TRI 2025 and DT 1	Dates sprayed: 21.04.95
Plot size :	100 bushes per plot	(day of prune)
		24.04.95
Replication :	Three	(3 days after prune)
Design :	Split-plot type	Bud count : 31.05.95
Date pruned :	21.04.95	Tipping : 01.09.95
		Plucking : November '95

Experiment 2. Mid-country (762 m amsl) -
A. Field No. 7, Factory Division, Hantane Estate, Hantane

Type of tea :	Seedling	Dates sprayed: 18.05.95
Plot size :	100 bushes per plot	(day of prune)
Replication :	Five	25.05.95
		(7 days after prune)
Design :	RCBD	Bud count: 21.07.95
Date pruned :	18.05.95	Tipping : 27.09.95
		Plucking : October '95

B. Field No. 9A, Galphele Estate, Panwila

Type of tea :	Clone TRI 2023	Dates sprayed: 18.08.95
		(day of prune)
Plot size :	50 bushes per plot	25.08.95
Replication :	Five	(7 days after prune)
		Bud count : 28.09.95
Design :	RCBD	Tipping : 10.11.95
Date pruned :	18.08.95	Plucking : December '95

Experiment 3. Low-country (30 m amsl) - Field No.7
TRI substation, Talgampola

Type of tea : TRI 2027
Plot size : 40 bushes per plot
Replication : Five
Design : RCBD
Date pruned : 22.06.95

Dates sprayed: 22.06.95
(day of prune)
29.06.95
(7 days after prune)
Bud count : 01.08.95
Tipping : 28.09.95
Plucking : November '95

RESULTS

Experiment 1. Up-country, St. Coombs Estate

The bud count and tipping weights are given in Table 1.

TABLE 1 – *Effect of sprays of hydrogen cyanamide on bud count and tipping weight*

Treatments	*Bud break No. per plot*		*Tipping weight(kg) Mean per plot*	
	TRI 2025	*DT1*	*TRI 2025*	*DT1*
Unsprayed control for DOP	304	135	7.30	7.85
Sprayed on DOP at 1%	289(-5)*	209(55)	7.48(2)	8.19(4)
Sprayed on DOP at 2%	315(4)	154(14)	6.67(-9)	9.72(24)
Unsprayed control for 3 DAP	303	124	5.68	9.52
Sprayed 3 DAP at 1%	274(-10)	186(50)	7.36(30)	7.63(-20)
Sprayed 3 DAP at 2%	358(18)	165(33)	8.20(44)	11.10(16)

Note: DOP = Day of pruning DAP = Days after pruning
* Figures in parenthesis indicate per cent increase or decrease (negative values) over control.

In clone TRI 2025, Dormex at the higher concentration increased bud number while in clone DT 1 the 1% concentration caused greater bud burst. In clone TRI 2025, both concentrations increased the tipping weight when sprayed on the third day after prune while, in clone DT 1, the 2% concentration increased the tipping weight.

The yields obtained in the first year (November '95 to October '96) as well as in the second year (November '96 to June '97) are presented in Table 2.

TABLE 2 – *Effect of sprays of hydrogen cyanamide on yield (kg made tea ha^{-1})*

Treatments	*Clone TRI 2025*	*Yield*
	1st year (Nov'95-Oct'96)	*2nd year (Nov'96-June'97)*
Unsprayed control for DOP	1575	1618
Sprayed on DOP at 1%	1830(16)*	1731(7)
Sprayed on DOP at 2%	1715(9)	1680(4)
Unsprayed control for 3 DAP	1536	1705
Sprayed 3 DAP at 1%	1756(14)	1767(4)
Sprayed 3 DAP at 2%	1694(10)	1711(0.4)
	Clone DT 1	
Unsprayed control for DOP	1871	1769
Sprayed on DOP at 1%	2011(7)	1801(2)
Sprayed on DOP at 2%	2127(14)	1833(4)
Unsprayed control for 3 DAP	1770	1829
Sprayed 3 DAP at 1%	2072(17)	1936(6)
Sprayed 3 DAP at 2%	1880(6)	1893(3)
LSD (P=0.05)	211	NS

Note: DOP = Date of pruning DAP = Days after pruning
*Figures in parenthesis indicate per cent increase over control.

In the first year, irrespective of time of spray, 1% concentration of Dormex enhanced yields in clone TRI 2025 while in clone DT 1 the 1% concentration increased yields to a greater extent when sprayed at three days after prune. In the eight month period of the second year there were no differences in yield between the treatments and the trial was terminated.

Experiment 2. Mid-country, Hantane and Galphele Estates

The bud count and tipping weights of the trials conducted at Hantane and Galphele Estates are given in Table 3.

TABLE 3 - *Effect of sprays of hydrogen cyanamide on bud count and tipping weight*

	Hantane		*Galphele*	
	Bud break Mean/bush †	*Tipping weight (kg ha^{-1})*	*Bud break Mean/bush*	*Tipping weight (kg ha^{-1})*
Treatments				
Unsprayed control for DOP	33	139	55	3246
Sprayed on DOP at 1%	36(9)*	145(4)	61(11)	3934(21)
Sprayed on DOP at 2%	40(21)	159(14)	62(13)	3812(17)
Unsprayed control for 7 DAP	36	178	59	3285
Sprayed 7 DAP at 1%	39(8)	188(6)	57(3)	3734(14)
Sprayed 7 DAP at 2%	38(6)	161(-10)	53(10)	3540(8)

Note: DOP = Day of pruning DAP = Days after pruning

† Mean of 5 bushes/plot

*Figures in parenthesis indicate per cent increase or decrease (negative values) over control.

At Hantane, bud counts and tipping weights were greater at 2% concentration sprayed on the day of pruning. At Galphele, better response was seen to both concentrations when the sprays were given on the day of prune.

The yields obtained in the first year as well as in the second year till termination of trials in respect of Hantane and Galphele Estates are given in Table 4.

TABLE 4 - *Effect of sprays of hydrogen cyanamide on yield (kg made tea ha^{-1})*

	Yield			
	Hantane		*Galphele*	
	1st year (Oct.95-Sep.96)	*2nd year (Oct.96-Aug.97)*	*1st year (Dec.95-Nov.96)*	*2nd year (Dec.96-June97)*
Treatments				
Unsprayed control for DOP	1176b	628b	3893b	1627a
Sprayed on DOP at 1%	1352ab(15)*	793a(26)	4448a(14)	1827a(12)
Sprayed on DOP at 2%	1411a(20)	780a(24)	4272ab(10)	1870a(15)
Unsprayed control for 7 DAP	1179b	643a	3947b	1717a
Sprayed 7 DAP at 1%	1451a(23)	756a(17)	4181ab(6)	2025b(18)
Sprayed 7 DAP at 2%	1411a(20)	677ab(5)	4101ab(4)	1728a(1)

Note: DOP = Day of pruning DAP = Days after pruning

Means followed by the same letter are not significantly different from each other.

*Figures in parenthesis indicate per cent increase in yield over control.

At Hantane, a better yield response was obtained when Dormex was sprayed at 1% seven days after prune. The treated plots continued to maintain yield differences in the second year as well.

At Galphele, a better response was seen at 1% concentration when sprayed on the day of prune. In the second year there were no differences in yield between any of the treatments sprayed on day of prune; however, the 1% concentration sprayed 7 days after prune continued to give enhanced yields.

Experiment 3. Low-country, TRI substation, Talgampola

Table 5 presents data on bud count, tipping weight as well as the yield obtained in the first year and eight months of the second year.

TABLE 5 – *Effect of sprays of hydrogen cyanamide on bud count, tipping weight and yield (kg made tea ha^{-1})*

			Yield	
	Bud break Mean/bush †	*Tipping weight (kg/plot)*	*1st year (Nov.95-Oct.96)*	*2nd year (Nov.96-June97)*
Treatments				
Unsprayed control for DOP	26	25	3250	2897
Sprayed on DOP at 1%	28(8)*	27(8)	3564(10)	2933(1)
Sprayed on DOP at 2%	32(24)	34(36)	3492(7)	2981(3)
Unsprayed control for 7 DAP	33	27	3269	3005
Sprayed 7 DAP at 1%	34(2)	33(22)	3822(17)	3100(3)
Sprayed 7 DAP at 2%	32(-3)	27(0)	3515(8)	3235(8)
LSD(P=0.05)			481	NS

Note: DOP = Day of pruning DAP = Days after pruning
† Mean of 5 bushes/plot
*Figures in parenthesis indicate increase or decrease (negative value) over control.

Bud break and tipping weight were greater at 2% concentration sprayed on day of pruning. Dormex at 1% concentration sprayed 7 days after prune enhanced yields compared to the unsprayed control. There was no difference in yield between any of the treatments during the eight months of the second year when the trial was terminated.

DISCUSSION

The present study was undertaken to determine whether application of the plant growth regulator, hydrogen cyanamide (Dormex) would result in yield increases that would offset at least to some extent the loss in yield incurred in the year of prune. Application of Dormex at 1 and 2% concentrations increased bud break in the pruned bushes at all locations of this study (Tables 1, 3 and 5). In the up-country Dormex markedly increased bud break in clone DT 1 which is somewhat slow growing compared to the more vigorous clone TRI 2025 indicating differences in the response of clones (Table 1). In the mid-elevation tipping weight was greater in clonal than in seedling tea (Table 3). In the low elevation 2% Dormex sprayed on the day of prune enhanced bud break and tipping weight (Table 5). In North-East India, preliminary trials on Dormex indicated more and early bud break in pruned tea (Anon. 1990).

At all elevations, Dormex proved effective in increasing yields, the increases being noted in both clonal and seedling tea. In the up-country in clone TRI 2025 yield increases of the order of 16% (at 1% concentration) was seen when Dormex was sprayed on the day of prune; clone DT 1 showed a better response to 1% concentration sprayed three days after prune indicating clonal differences (Table 2). In the mid-elevation, seedling tea responded better to 1% cocentration sprayed seven days after prune (Table 4). In the low elevation, 1% concentration improved yields (Table 5). Even though yield increases of about 15 to 20% have been obtained in this study, under commercial conditions yield increases of about 10 to 12% is not improbable.

Trials conducted in South India have shown that spraying of hydrogen cyanamide (0.5%) on pruned frames on the same day of pruning effectively hastened and improved bud break resulting in early recovery, tipping and increased crop without affecting the health and productivity of the bushes (Anon. 1993). There was no residual effect of the treatment either on health or quality of made tea; on an average, 10-15% crop increase was observed.

Although yield increases were monitored in the year of prune, the trials continued for much of the second year as well in order to ascertain whether there was a depression in crop following the initial boost. Work with other growth promoters, notably gibberellic acid have shown that consequent to sprays of this chemical dry matter yields showed a peak response at six months after which the yields declined rapidly (Kulasegaram and Kathiravetpillai, 1974). However, it is to be noted that in this study there was no crop loss during the second year of the trial. In the mid-elevation the increase in crop seen in the first year continued even during the second year. It is probable that this could be due to a favourable response to the application of the plant growth regulator which would have improved the health of the bush with better starch reserves resulting in improved yields.

It is to be noted that hydrogen cyanamide is rapidly broken down in the soil into urea, ammonium and is finally converted into nitrate.

If the overall performance of each concentration is evaluated by averaging the yield irrespective of the time of spray, the yield obtained with 1% concentration shows promise. It is envisaged that under commercial conditions yield increases of at least 10% could be obtained by spraying Dormex at 1% concentration (5 l Dormex in 500 l water ha^{-1}). Spray applications should be made only after pruning bushes and best results are obtained if spraying could be done as soon as possible after pruning and in any case not later than seven days after prune. It is important that there is a four hour rain free period following spraying. The pruned frames must be drenched thoroughly to drip. If more spray solution is needed it could be prepared and used at the same concentration. It must be ensured that each and every bush is sprayed thoroughly as only one spray application is given. In preparing the spray solution only plastic containers must be used. All metal containers should be avoided. Store Domex in a cool place away from sunlight.

Dormex is not compatible with other chemicals. If hydrated lime is to be used for mossing and ferning, it is preferable to apply the lime at least two days after completion of Dormex spray application. If a field is earmarked for Dormex spray, proper planning is essential and it will be prudent to prune such a field early preferably in March, when starch reserves are highest (Anandacoomaraswamy, 1997).

Sprayers should use gloves and protective clothing to prevent any skin irritation. As only one spray application is given in a pruning cycle, it is important that each and every bush is sprayed thoroughly; the need for proper supervision cannot be overemphasized.

An analysis of the financial benefits of embarking on a programme of Dormex application of pruned fields indicates that such an exercise is economically feasible.

Based on an estimated yield increase of 10 per cent in the first year of the pruning cycle, cost of chemical at Rs 700 per litre, current labour wage of Rs 95.45 per day and the 1996 NSA of Rs 103 per kg, the financial gain per hectare from using Dormex at 1% concentration is calculated as follows.

Yield range(kg/ha)	800	900	1000	1100	1200
Estimated yield increase(kg)	80	90	100	110	120
Increased cost(Rs)[1]	3349	3529	3995	4175	4355
Application cost(Rs)[2]	3786	3786	3786	3786	3786
Additional revenue(Rs)	8240	9270	10300	11330	12360
Net gain(Rs/ha)	1105	1955	2519	3369	4219

[1] Additional 20–23 man-days for plucking at Rs 94.45 per day and Rs. 18.00 per kilo for manufacturing

[2] Includes cost for chemical and 3 labourers per ha

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REFERENCES

ANANDACOOMARASWAMY, A. (1997). Root starch and recovery from pruning. *TRI Update.* **2** (1), 2.

ANON. (1990). Report on R & D Activities. *Ann. Rep. Tock. Exp. Stn.* 1989-90.

ANON. (1993). Report of Plant Physiology. *Ann. Rep. Sci. Dept. UPASI,* 1993.

HEMBERG, T. (1949*a*). Significance of growth-inhibiting substances and auxins for the rest-period of potatoes. *Physiol. Plant.2*, 24-36.

HEMBERG, T. (1949*b*). Growth-inhibiting substances in terminal buds of *Fraxinus. Physiol. Plant.* **2,** 37-44.

KULASEGARAM, S. (1969). Studies on the dormancy of tea shoots. 1. Hormonal stimulation of the growth of dormant buds. *Tea Q.* **40**, 31-46.

KULASEGARAM, S. and KATHIRAVETPILLAI, A. (1972). Effects of nutrition and hormones on growth and apical dominance in tea (*Camellia sinensis* (L.) O. Kuntze). *J.hort.Sci.* **47**, 11-24.

KULASEGARAM, S. and KATHIRAVETPILLAI, A. (1974). The influence of climate and gibberellic acid on yield of tea clones *(Camellia sinensis L.). Tea Q.* **44**, 100-112.

SHIKHAMANY, S.D. and REDDY, N.N. (1989). Comparative efficacy of cyanamide and thiourea sprays on budbreak in Thompson seedless grape. *Indian Grape J.* **3-5,** 37-42.

ZELLEKE, A. and KLIEWER, W.M. (1989). The effects of hydrogen cyanamide on enhancing the time and amount of budbreak in young grape vineyards. *Am. J. Enol. Vitic.* **40** (1), 47-51.