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Studies on the Chemical Control of Sugarcane Stem Borer

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ABSTRACT

Different doses of marshal 6G and padan 4G were applied @ 3.0 kg a.i ha^{-1} in soils for the control of sugarcane stem borer, *Chilo tumidicostalis* Hampson at varied frequencies. All the treatments significantly controlled the pest. However, padan 4G @ 3.0 kg a.i ha^{-1} applied in June, July and August gave desired level of effectiveness (over eighty percent) and hence may be recommended against sugarcane stem borer.
Key words: Sugarcane, *Chilo tumidicostalis*, chemical control.

INTRODUCTION

Stem borer, Chilo tumidicostalis Hampson is a serious pest of sugarcane in Bangladesh (Alam and Miah, 1997). Generally its incidence is in vogue from May to September, however, it may attack before or beyond that period (Alam *et al.* 1990).

Primary infestation is caused by newly hatched larvae aggregating in the top 3-5 internodes. Tunneling of internodes is so severe that the dried top portion of the cane easily breaks off by wind or jerk. In the phase of secondary infestation, grown up borer larvae migrate to adjacent canes or to the lower healthy portion but cane tops do not dry up in this case (Avasthy and Tiwari, 1986). Losses in yield and sucrose are more due to primary than secondary infestation. Khanna et al. (1957) reported that the loss in tonnage varies from 8.2-12.6 percent and the loss in sugar from 10.7-48.6 percent in Bihar. Gupta and Avasthy (1959) reported that in West Bengal of India, the loss in yield varies from 35-100 tonnage per hectare while recovery is reduced by 3-26 percent.

There is no insecticide recommended against sugarcane stem borer in Bangladesh. Many chemicals were tested against this pest but none could be recommended. Mechanical and cultural controls are not enough to keep the pest population below economic injury level. There is an urgent need to recommend insecticides against this pest. It is obvious that granular pesticides are comparatively less harmful to natural enemies. Keeping the above in mind this experiment was conducted with two granular insecticides viz. marshal 6G and padan 4G at different doses and timings.

MATERIALS AND METHODS

The experiment was set up during the cropping season 1996-97 at three locations viz. Jamalpur farm and Mohan farm of Thakurgaon sugar mills, Thakurgaon and Shahebgonj farm of Rangpur sugar mills, Gaibandha. Individual plot size was 6 m x 5 m, total number of treatments were 9, replicated 3 times in a RCB design. Plot to plot and block to block gap was 2 m.

The following treatments were included in the experiment :

T_1 - Marshal 6G @ 3.0 kg a.i ha^{-1} in June and July
T_2 - Marshal 6G @ 3.0 kg a.i ha^{-1} in July and August
T_3 - Marshal 6G @ 3.0 kg a.i ha^{-1} in June, July and August
T_4 - Marshal 6G @ 3.0 kg a.i ha^{-1} in June and August
T_5 - Padan 4G @ 3.0 kg a.i ha^{-1} in June and July
T_6 - Padan 4G @ 3.0 kg a.i ha^{-1} in July and August
T_7 - Padan 4G @ 3.0 kg a.i ha^{-1} in June, July and August.
T_8 - Padan 4G @ 3.0 kg a.i ha^{-1} in June and August
T_0 - Check (Untreated)

The granules were applied in soils on both sides of the cane rows in furrows made by spade and then were covered with spade. Intercultural operations like weeding, earthing up, mulching, irrigation were practiced as usual. Data were collected in the month of September , one month after the final application of insecticides.

RESULTS AND DISCUSSION

From the Table 1 reveals that at Jamalpur farm significant difference among the treatments was found and each treatment had potential in controlling the pest, however, over eighty percent control was achieved only when padan 4G was applied 3 times @ 3.0 kg a.i ha^{-1}. Almost same result was found at Mohan farm (Table 1).

Table 1. Efficacy of Marshal 6G and Padan 4G in controlling stem borer at three different farms (Locations), 1996-97.

Treatments (Chemicals)	% infestation of SB (Mean of 3 replications)						Mean % Efficacy
	Jamalpur farm		Mohan farm		Shahebgonj farm		
	Mean	% control	Mean	% control	Mean	% control	
T_1 – Marshal 6G @ 3.0 kg a.i ha^{-1} (June and July)	12.99 ab*	26.40	2.68 bc	53.06	6.46 bc	76.12	51.86
T_2 – Marshal 6G @ 3.0 kg a.i ha^{-1} (July and August)	8.77 bc	50.31	2.19 bcd	61.65	7.69 bc	74.57	61.17
T_3 – Marshal 6G @ 3.0 kg a.i ha^{-1} (June, July and August)	6.47 cd	63.34	2.20 bc	61.47	5.34 bc	80.26	68.35
T_4 – Marshal 6G @ 3.0 kg a.i ha^{-1} (June and August)	9.67 bc	45.32	3.43 ab	39.93	12.08 b	55.34	46.86
T_5 – Padan 4G @ 3.0 kg a.i ha^{-1} (June and July)	7.97 bcd	54.84	2.55 bc	55.34	5.02 bc	81.44	63.87
T_6 – Padan 4G @ 3.0 kg a.i ha^{-1} (July and August)	5.27 cd	70.14	1.46 cd	74.43	4.89 bc	81.42	75.83
T_7 – Padan 4G @ 3.0 kg a.i ha^{-1} (June, July and August)	3.20 d	81.87	1.08 d	81.08	3.07 c	88.65	83.86
T_8 – Padan 4G @ 3.0 kg a.i ha^{-1} (June and August)	6.54 bcd	62.92	2.09 bcd	63.40	5.14 bc	81.00	69.10
T_0 Check (Untreated)	17.65 a	-	5.71 a	-	27.05 a	-	-
LSD 0.05	1.073		0.6312		1.149		

* Figures followed by the same letter(s) are not significantly different at 0.05 level (LSD)

At Shahebgonj farm (Table 1) there was significant difference among the treatments. All the treatments satisfactorily controlled stem borer but over eighty percent control were achieved in marshal 6G @ 3.0 kg a.i ha^{-1} applied in June, July and August; padan 4G @ 3.0 kg a.i ha^{-1} applied in June and July; applied in July and August; applied in June, July and August and applied in June and August.

It has been stated earlier that there is no chemical recommended against stem borer of sugarcane in Bangladesh and India where this species is prevalent. Therefore, literature on its chemical control is scarce. Only mechanical and cultural control methods are recommended (Avasthy and Tiwari, 1986; Alam *et al.* 1990).

The mean result (Table 1) indicates that only Padan 4G @ 3.0 kg a.i ha^{-1} if applied in the month of June, July and August gave expected level of control (83.86%) of the target pest. Considering the above results and discussion it is concluded that padan 4G @ 3.0 kg a.i ha^{-1} may be recommended against sugarcane stem borer to be applied in June, July and August for desired level of control of the pest.

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MATERIALS AND METHODS

The study was conducted with eight selected sugarcane clones viz. I 61-90, I 344-90, BO. 91, I 155-91, I 209-91, I 41-92, I 153-92, I 216-92 and standard Isd 16. Individual clone was planted in row 20m long in three replications. Application of recommended dose of fertilizers and normal cane management practices were done. The cane samples were collected randomly from three replications for chemical analysis.

The chemical analyses for sucrose percent and reducing sugars percent were started from 15th of September, 1999; then 15th of every month and continued upto 15th March, 2000. The cane juice was clarifiedwith basic lead sub-acetate. Brix and pol were determined with Brix hydrometer and automatic Polarimeter (Anon. 1970). The juice was analysed for sucrose percent and reducing sugars percent using a formula given by Mathur (1978).

For statistical analyses of data, following two probabilistic regression models were used.

$$Y_{1ij}=\beta_{10}+\sum\beta_{1i}d_{ij}+\beta_{19}t_j+\beta_{110}t_j^2+\beta_{111}r_j+e_{1j} \quad \text{.....(i)}$$

$$r_{2ij}=\beta_{20}+\sum\beta_{2i}d_{ij}+\beta_{29}t_j+\beta_{210}t_j^2+e_{2j} \quad \text{.....(ii)}$$

Where, Y's are the sucrose per cent; r's are the reducing sugars; d's are the dummy variables for clones; b's are the regression co-efficients; t's are the number of month [beginning with 1 for the month of September and ending with 7 (considering cumulative figure) for March [1 stands for total number of days between 15th of any two consecutive months]; e's are independent random normal variables with mean zero and constant variance s2; the summation (å) is over i; i=1, 2, ..., 8 and j=1, 2, ..., 63; di=1 for the i-th clone and di=0 for any clone other than i-th clone. When all d's are simultaneously set equal to zero, the equation of variety Isd 16 will arise. The two deterministic models are :

$$\hat{Y}_{1i}=b_{10}+\sum b_{1i}d_i+b_{19}t+b_{110}t^2+b_{111}r \quad \text{..... (iii)}$$

$$\hat{r}_{2i}=b_{20}+\sum b_{2i}d_i+b_{29}t+b_{210}t^2 \quad \text{.....(iv)}$$

Where b's are the estimators for β's and $\hat{Y}$ and $\hat{r}$ are the estimators for Y and r. Consider the model (iii) and when all $d_i=0$, the model reduces to

$$\hat{Y}_1=b_{10}+b_{19}t+b_{110}t^2+b_{111}r \quad \text{.....(v)}$$

which is an equation for variety Isd 16. When $d_i=1$, the model reduces to

$$\hat{Y}_{1i}=b_{10}+b_{1i}+b_{19}t+b_{110}t^2+b_{111}r \quad \text{.....(vi)}$$

which is an equation for the i-th clone. Now, (vi) - (v) is yielding $b_{1i}=\hat{Y}_{1i}-\hat{Y}_1$.

Hence if b1i is significant, the estimate Y1i and Y1 will be significantly different which signifies that the variety Isd 16 and the i-th clone are significantly different in sucrose percent. Similar is the case for reducing sugars. In these deterministic equations [(iii) and (iv)], when t is put equal to 1, it will estimate sucrose content in equation (iii) and

reducing sugars in equation (iv) for 15th of September. When t is put equal to 2, it will estimate sucrose content in equation (iii) and reducing sugars in equation (iv) for 15th of October.

Similar is the case for other months. For any other value of t, say t=4.72, it will estimate sucrose content in equation (iii) and reducing sugars in equation (iv) for a day in the 1st week of January or say t=6.14, it will estimate sucrose content in equation (iii) and reducing sugars in equation (iv) for a day in the 3rd week of February.

The overall F-test for testing a null hypothesis (all regression co-efficients) of the type
$H_0 : \beta_1 = \beta_2 = \beta_3 = ... = \beta_k = 0$ or $R=0$ against an alternative
H_a : Atleast one of the β co-efficients is non-zero or $R \neq 0$

Test statistic $F = \dfrac{SSB/k}{SSE/(N-k-1)}$ **, df=k and N-k-1**

Where, R^2=SSB/TSS, R= Multiple correlation co-efficient
TSS= Total sum of squares, SSB= Regression sum of squares
SSE= Residual sum of squares

F-test for testing a null hypothesis (a few of the regression co-efficients) type :

$H_0 : \beta_{g+1} = \beta_{g+2} = ... = \beta_k = 0$ against an alternative
H_a : Atleast one of the β parameters under test is non-zero.

Test statistic $F = \dfrac{(SSB_1 - SSB_2)/(k-g)}{SSE_2/[N-(k+1)]}$

Where, SSE_1=Sum of squared errors for the reduced* model
SSE_2= Sum of squared errors for the complete** model
k-g=No. of β parameters specified in H_0
k+1= No. of β parameters in the complete model
N=Sample size
and $v_1 = k-g$=degree of freedom (df) for the numerator
$v_2 = N-(k+1)$= degree of freedom (df) for the denominator

Rejection region : $F > F_\alpha$ [McClave and Benson (1985)]

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* Reduced model : $y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_g x_g + e$
** Complete model : $y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_g x_g + \beta_{g+1} x_{g+1} + \beta_{g+2} x_{g+2} + ... + \beta_k x_k + e$

RESULTS AND DISCUSSION

The two regression equations (Table 1) were determined which were explained 88 % of the variability in sucrose by the variety and clones, number of months and reducing sugars and 77 % of the variability in reducing sugars by the variety and clones, number of months with highly significant multiple correlation co-efficient. Almost all the partial regression co-efficients of dummy variables for equation (iii) being negative and highly significant revealed that the clones corresponding to them were significantly lower in sucrose and reducing sugars than the variety lsd 16 except the clone I 344-90 which is consistant with lsd 16. In case of equation (iv), 50 % of the partial regression co-efficients being negative and insignificant showed that the clones corresponding to them were consistantly lower than lsd 16 in reducing sugars.

Table 1. Effects of variety and clones, number of month, reducing sugars on sucrose content and reducing sugars in cane.

Independent variables	Co-efficients of equation (iii) for sucrose content (Y)	Co-efficients of equation (iii) for reducing sugars (Y)
Intercept	6.7039965 **	1.14698 **
d_1 (clone I 61-90)	-1.0671311 **	-0.0686 ns
d_2 (clone I 344-90)	-0.2488512 ns	-0.1043 ns
d_3 (clone BO-91)	-1.3287463 **	-0.0214 ns
d_4 (clone I 155-91)	-0.9070091 **	0.26143 **
d_5 (clone I 209-91)	-0.7139883 **	0.00143 ns
d_6 (clone I 41-92)	-0.88842 **	0.15857 *
d_7 (clone I 53-92)	-0.7120524 **	0.16857 *
d_8 (clone I 216-92)	-1.0068166 **	0.18000 *
t (month)	1.9018461 **	-0.2850 **
t^2 (month^2)	-0.2098767 **	0.02321 **
r (reducing sugars)	-1.2081619 **	-
$100R^2$	88.83 %	77.63 %
R	0.9425 **	0.8811 **

* indicates significant at 5 % level of significance.

**indicates significant at 1 % level of significance.

However, the number of months was found to have quadratic effect (Table 1) on sucrose [equation (iii)] and reducing sugars [equation (iv)] but in sign of the regression co-efficients, one equation was reverse of the other which revealed that with the increase of the number of months, sucrose increased and reducing sugars decreased. As the reducing sugars decreased with time increased, sucrose was linearly increased since sucrose was a linear (positive) function of reducing sugars. Corresponding to the variety and to each clone, one regression equation was determined (Table 2). They were different in case of intercept only.

Table 2. Estimated regression equations for sugarcane variety and eight clones.

Variety or Clone	Regression equations	
	Sucrose (Y)	Reducing sugars (Y)
Variety lsd 16	$6.704+1.902t-0.20997t^2-1.2082r$	$1.147-0.285t+0.0232t^2$
Clone I 61-90	$5.637+1.902t-0.20997t^2-1.2082r$	$1.078-0.285t+0.0232t^2$
Clone I 344-90	$6.455+1.902t-0.20997t^2-1.2082r$	$1.043-0.285t+0.0232t^2$
Clone BO-91	$5.375+1.902t-0.20997t^2-1.2082r$	$1.126-0.285t+0.0232t^2$
Clone I 155-91	$5.797+1.902t-0.20997t^2-1.2082r$	$1.408-0.285t+0.0232t^2$
Clone I 209-91	$5.990+1.902t-0.20997t^2-1.2082r$	$1.148-0.285t+0.0232t^2$
Clone I 41-92	$5.816+1.902t-0.20997t^2-1.2082r$	$1.306-0.285t+0.0232t^2$
Clone I 153-92	$5.992+1.902t-0.20997t^2-1.2082r$	$1.316-0.285t+0.0232t^2$
Clone I 216-92	$5.697+1.902t-0.20997t^2-1.2082r$	$1.327-0.285t+0.0232t^2$

From these equations, values were calculated which showed the trend of sucrose (Table 3) and reducing sugars (Table 4) with times (month) i.e. For each clone and variety how the sucrose was increasing or reducing sugars were decreasing beginning from the 1st row (beginning of September) and reached to a maximum or minimum (asterisk rows).

Table 3 . Trend values of sucrose content in cane with the change of months.

(Date) of Month (Number)	Sucrose content of variety and clones.								
	Isd 16	I 61-90	I 344-90	BO-91	I 155-91	I 209-91	I 41-92	I 153-92	I 216-92
(15-09-1999) of September (1)	7.3265	6.3429	7.2032	6.0229	6.1042	6.6113	6.2464	6.4103	6.1021
(15-10-1999) of October (2)	8.8589	7.8752	8.7355	7.5552	7.6365	8.1437	7.7788	7.9427	7.6344
(15-11-1999) of November (3)	9.9152	8.9316	9.7919	8.6116	8.6929	9.2000	8.8351	8.9990	8.6907
(15-12-1999) of December (4)	10.4955	9.5119	10.3722	9.1919	9.2732	9.7803	9.4154	9.5794	9.2711
(07-01-1999) of January (4.72) *	10.6186	9.6350	10.4953	9.3150	9.3963	9.9034	9.5385	9.7025	9.3942
(15-01-2000) of January (5)	10.5999	9.6162	10.4765	9.2962	9.3775	9.8847	9.5198	9.6837	9.3754
(15-02-2000) of February (6)	10.2282	9.2446	10.1049	8.9246	9.0059	9.5130	9.1481	9.3120	9.0037
(15-03-2000) of March (7)	9.3805	8.3969	9.2572	8.0769	8.1582	8.6653	8.3004	8.4644	8.1561

* indicates the row giving the maximum sucrose content for each clone.

Table 4 . Trend values of reducing sugars in cane with the change of months.

(Date) of Month (Number)	Reducing sugars of variety and clones.								
	Isd 16	I 61-90	I 344-90	BO-91	I 155-91	I 209-91	I 41-92	I 153-92	I 216-92
(15-09-1999) of September (1)	0.8852	0.8162	0.7812	0.8642	1.1462	0.8862	1.0442	1.0542	1.0652
(15-10-1999) of October (2)	0.6698	0.6008	0.5658	0.6488	0.9308	0.6708	0.8288	0.8388	0.8498
(15-11-1999) of November (3)	0.5008	0.4318	0.3968	0.4798	0.7618	0.5018	0.6598	0.6698	0.6808
(15-12-1999) of December (4)	0.3782	0.3092	0.2742	0.3572	0.6392	0.3792	0.5372	0.5472	0.5582
(15-01-2000) of January (5)	0.3020	0.2330	0.1980	0.2810	0.5630	0.3030	0.4610	0.4710	0.4820
(15-02-2000) of February (6) and (19-02-2000) of	0.2722	0.2032	0.1682	0.2512	0.5332	0.2732	0.4312	0.4412	0.4522
February (6.14) * (15-03-2000) of March (7)	0.2717	0.2027	0.1677	0.2507	0.5327	0.2727	0.4307	0.4407	0.4517
	0.2888	0.2198	0.1848	0.2678	0.5498	0.2898	0.4478	0.4578	0.4688

* indicates the row giving the minimum reducing sugars for each clone.

Hence, it could be concluded that any variety or clone might show different sucrose and reducing sugars percent but the time of yielding maximum sucrose percent was the same. Similar result arose for reducing sugars percent.

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