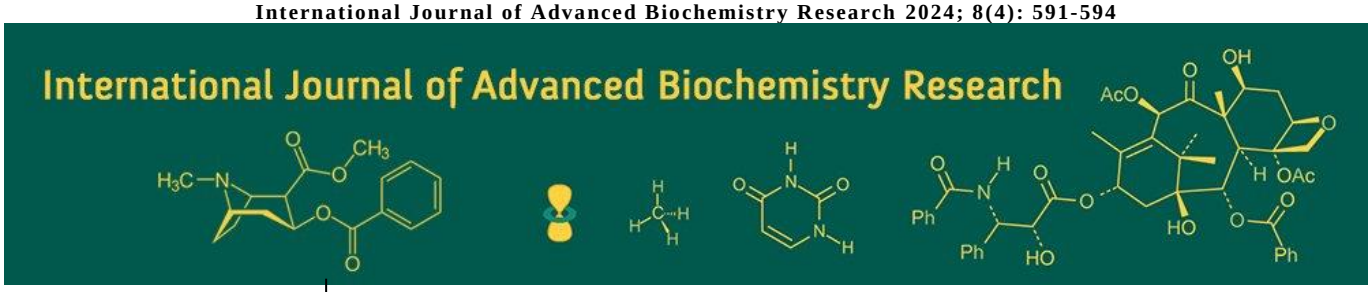

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Assessment of IDM modules with some fungicides for whip smut of sugarcane in Chhattisgarh

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Abstract
Among the fungal diseases of sugarcane whip smut (*Ustilago scitaminea*) is the most serious and widely spread disease of sugarcane and causes a significant reduction in cane quantity and quality in all Sugarcane growing areas of India including Chhattisgarh also. Considering the importance of the disease an experiment was conducted with sugarcane set treatment with Tebuconazole against whip smut disease through OFT in Kabirdham district of Chhattisgarh during Kharif season 2016-17 and 2017-18 at different location of farmer's field on variety CO68032 by supervision of Indira Gandhi Krishi Vishwavidyalaya, Krishi Vigyan Kendra, Kabirdham (Chhattisgarh). The sugarcane set was treated with Tebuconazole - 50% @ 0.1% solution for half to one hour before sowing. The experiment was observed by calculation of No. of infested plants/m^2, Disease Incidence (%), No of infected shoots and yield data with cost: benefit ratio. Tebuconazole showed good response in all respective parameters with low cost high benefit ratio compare to farmer practices (without any chemical treatment).

Keywords: Sugarcane, whip smut, red rot, fungicide, Chhattisgarh

Introduction
Sugarcane is an important commercial crop of the world and in India also because it's grown in diversified climatic condition i.e. tropical and sub-tropical. India is the only country in which sugarcane is grown in both types of the climate. However, considered as an important commercial crop in India and plays a pivotal role in agricultural and industrial economy of our country. India ranks second among the sugarcane growing countries of the world in the both area and production with area of cultivation 4.94 million hectares, average yield is 68.6 tons per hectare. Chhattisgarh, the state, which has been known as "rice bowl" of the country in the country's agriculture map, is now set to create a niche for itself in the sugar production and had reached. Considering the economic importance of sugarcane crop and availability of favourable soil and climatic conditions helped the state to be a leading producer the area in Chhattisgarh is 34.85 production 84.25 thousand metric tonnes and productivity 24.75 tons/ha (CEIC, 2020) [3]. The sugarcane crop requires 12-14 months for maturity and harvesting, and during the long duration crop, it suffers from many biotic and abiotic factors. Individually, pathogens and insect pests have a potential to decrease its production up to 20% (Ferreira *et al*. 1993; Rott *et al*., 2000 and Singh 2017) [5, 9, 11]. Among the biotic agents, fungal pathogens are most challenging. More than 100 fungi have been reported to cause diseases in sugarcane (Subhani *et al*., 2008) [14]. The most considerable sugarcane diseases are whip smut, red rot, leaf blast, sugarcane mosaic virus, pineapple disease, ratoon stunting disease, leaf scald, mottled stripe, pokkah boeing and wilt (Sivanesan and Waller 1986; Wada *et al*., 1999) [12, 17]. Among the diseases sugarcane smut disease is caused by *Ustilago scitaminea* (Stoll *et al*., 2003) [13], is an important disease in all sugarcane growing area of the worldwide (Comstock, 2000) [4]. Sugarcane smut being causes significant yield loss where farmers used susceptible cultivars with mismanagement practiced are applied (Comstock, 2000) [4]. Different measures are applied for control of sugarcane smut Sundar *et al*. (2012) [15], Sugarcane smut can be managed effectively by IDM method like use resistant cultivars (Comstock, 2000) [4]. Other control measures are hot-water treatment and fungicide application to seed-cane (stalk cuttings), and rouging of infested stools or plough out of infested crops (Comstock, 2000) [4]. Rouging of diseased plants will slow spread of the disease and has been used in countries with low labour cost (Lee - Lovick, 1978) [8] but is not

commercially feasible in India. Fungicides use in IDM is effective in controlling sugarcane smut in seed-cane (Ferreira *et al*. 1993 [5]; (Comstock, 2000) [4]. There was no information available on the efficacy of this fungicide in controlling sugarcane smut. We aimed to determine the efficacy of the fungicide like Tebuconazole in controlling sugarcane smut as a seed treatment by seed-cane Deeping method at planting time with integration of IDM in Chhattisgarh state.

Materials and Methods

An experiment was conducted through OFT on the assessment of IDM Modules with some Fungicides for Whip Smut of Sugarcane in Kabirdham district of Chhattisgarh during Kharif season 2016-17 and 2017-18 at different location of farmer's field under supervision of Indira Gandhi Krishi Vishwavidyalaya, Krishi Vigyan Kendra, Kabirdham (Chhattisgarh). The experiment was established with by using 'Zole' group of fungicides - Tebuconazole which have a systemic nature for treatment of sugarcane sets against whip smut as a dip treatment. All experiments were conducted using the highly smut-susceptible sugarcane 'CO68032'. Material was sourced from farmer fields Kawardha district of Chhattisgarh, which had a low incidence of smut at the time of collection. No smut was observed in the source plot. The sugarcane stalks were cut into one-bud cuttings using an electric saw and cleaned of extraneous matter by dipping in clean tap water. Farmer practice was used for comparison of IDM.

The sugarcane set was treated with Tebuconazole - 50% @ 0.1 % solution for half to one hour before sowing. One-bud cuttings were dipped into fungicide solution for 5 min at ambient temperature. A non-ionic surfactant APSA-80, (a product of Amway India Enterprises) was mixed with the dip at the rate of 0.50 ml liter^{-1}. After the fungicide application, the cuttings were allowed to dry at ambient temperature for approximately an hour before sowing of treated set. Farmer practices (with no fungicide) were used as control plot of experiment. A plant was considered to be infected if any tiller within the plant showed symptoms of whip smut. The incidence of smut was recorded at 2-weekly or monthly intervals, depending on the expression of disease. Most of the IDM approaches were applied including chemical application with some cultural methods like summer ploughing, removal of collateral/alternate host, field sanitation, selection of variety, time of sowing, plant spacing, use of organic manure, recommended dose of fertilizer application, grow certified seed and proper follow up of cultivated crop, to reduce the use of agriculture chemicals in sugarcane crop. All the agronomic practices of sugarcane crop were used as per recommendation. Sugarcane smut incidence (SDI) was monitored 6 months after sowing (Firehun *et al*., 2009) [6].

Observations were continued until May and June month of both consecutive year 2016 - 17 & 2017 - 18 respectively. Weight of the harvested canes in a row was recorded during harvesting and cane yield (tons) per hectare was estimated by the formula cane yield = [W × (10,000/R)]/(L × 1,000), where W = weight of the canes in each row (kg), R = row spacing (m), and L = row length (m). The incidence of the smut per plot was calculated as (diseased plants/total number plants) × 100.

Results and Discussion

A systemic fungicides of 'Zole group' - Tebuconazole 50 WP @ 0.1%) was assessed with IDM modules against whip smut of sugarcane disease (*Ustilago scitaminea*) as a protective measure by seed/sets treatment with use of other IDM cultural practices as a recommended practices (RP) and without any IDM practices use as a farmer practices (FP) in sugarcane cultivation up to sowing stage indicated as T_1 & T_2 Treatments (Table 1). The results indicate that T_2 is highly acceptable performance by increasing 7.23 % yield, with reduced the disease incidence by 2.88 % and disease intensity 7.31 % respectively an average of both the year (i.e. 2016-17 & 2017-18) compare to farmer practices. The average net income and B: C Ratio increased with 3.3:1, due to increment of yield is 166100/- Rs/ha. (Table1) Graphical representation of results for T_1 and T_2 showed similar trends as per table data is given in Fig. 1, 2, 3 and Fig. 4 respectively. Fungicides use in IDM is effective in controlling sugarcane smut in seed-cane (Ferreira *et al*. 1993 [5]; (Comstock, 2000) [4]. Fungicides provide a preventive and curative defence against whip smut disease (Firehun *et al*, 2009) [6]. In most cases, the application of fungicides led to a significant increase in the yield and quality of sugarcane (Toffano, 1969) [16]. The duration of the setts' dip in fungicidal solution is influenced on the efficacy of the fungicides as well as the disease development. In ratoon crop, which tends to be more affected with whip smut disease, the use of Spectrum (Azoxystrobin + Tebuconazole) as sett treatment and the foliar application of Tebuconazole at the time of ratoon initiation and one month of ratooning can effectively minimize the disease intensity (Kishore *et.al.*,2020). In most cases, the application of fungicides led to a significant increase in the yield and quality of sugarcane (Satyanarayana *et al.*, 2001; Bharathi, 2009 and Sundravadana *et al.*, 2011) [10, 2]. As whip smut has the potential to cause substantial losses in susceptible cultivars (Kumar *et al.*, 1989; Barnabas *et al*., 2012) [7, 1]. The varieties under cultivation should be replaced with resistant ones that have desirable agronomic characters. Regular monitoring, roughing and destruction of smut whip will help to reduce the inoculum. High economic importance of the disease implies a stringent need of development for the effective integrated smut management programs.

On the basis of the present study, it is concluded that whip smut is an aggressive and destructive disease of sugarcane and may cause substantial economic losses if proper control measures are not applied. Pre-sowing treatments of planting materials with suitable fungicides inhibit or eradicate the pathogen present within the sett tissues and subsequently, enhance the sett germination, plant growth and yield. Hence, sett dip with Tebuconazole 50% @ 0.1% can be recommended with IDM schedule for an effective management of sett transmitted sugarcane smut disease.

Table 1: Assessment of IDM Modules with some Fungicides for Whip Smut of Sugarcane

Sl. No.	Parameters	Treatments/Year			
		T_1 (Farmer Practice)		T_2 (Recommended Practice)	
		2016-17	2017-18	2016-17	2017-18
1.	Infected Canes %	4.22	4.89	1.61	1.74
2.	% Change in Parameters	61.85		64.41	
3.	Yield q/ha	711	748	865	856
4.	% Change in Yield	21.66		14.43	
5.	Cost of cultivation (Rs/ha)	78200		76100	
6.	Gross Return (Rs/ha)	-	199080	-	242200
7.	Net Income (Rs/ha)	120880	149640	166100	184780
8.	Average Net Return (Rs/ha)	-	120880	-	166100
9.	Benefit-Cost Ratio (Gross Return / Gross Cost)	1:2.91	1:2.54	1:3.42	1:3.18

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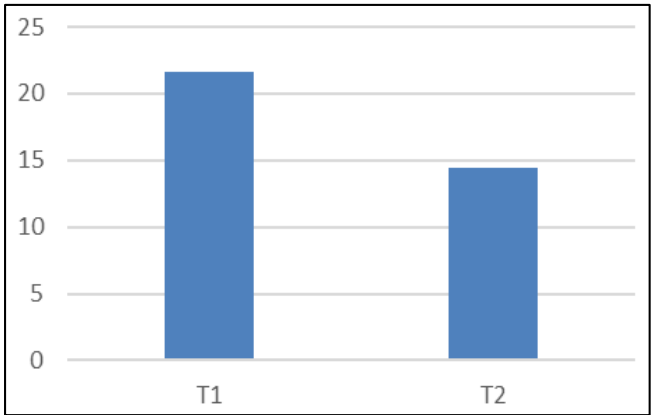
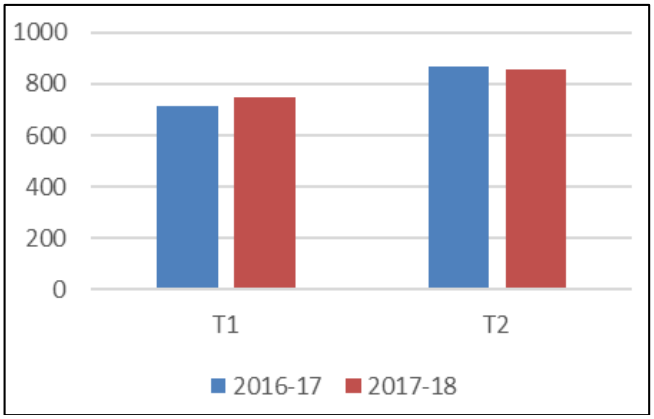
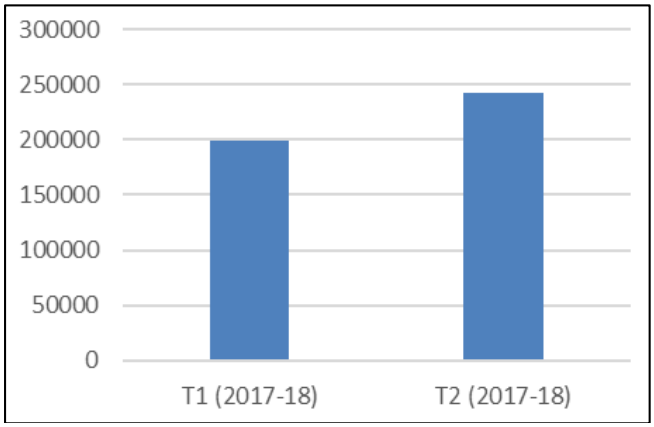


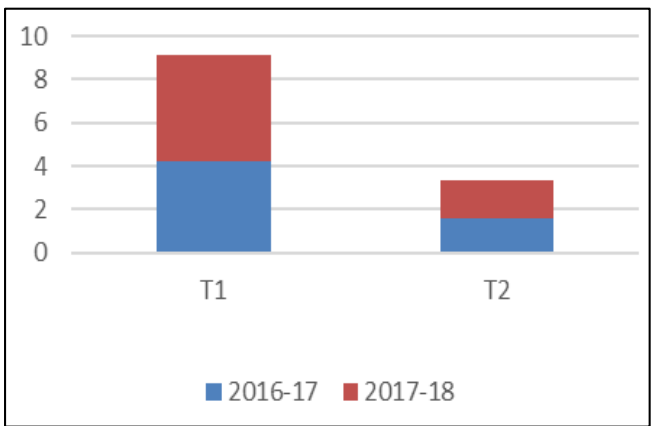
Effect of IDM Modules with some Fungicides for Whip Smut of Sugarcane on % change in yield



Effect of IDM Modules with some Fungicides for Whip Smut of Sugarcane on Yield q/ha



Effect of IDM Modules with some Fungicides for Whip Smut of Sugarcane on Gross Return.



Effect of IDM Modules with some Fungicides for Whip Smut of Sugarcane on % Infected Cane

Conclusion

In conclusion, the study underscores the severe threat whip smut poses to sugarcane cultivation, with potential significant economic repercussions if left unaddressed. Through meticulous assessment, it was evident that pre-sowing treatments incorporating systemic fungicides, particularly Tebuconazole 50 WP at 0.1%, significantly curtailed disease incidence and intensity, consequently augmenting yield by 7.23%. This translated into a notable increase in average net income and a favorable benefit-to-cost ratio of 3.3:1. Furthermore, the efficacy of fungicides in controlling whip smut, as supported by previous research, underscores their pivotal role in integrated disease management strategies. As whip smut continues to threaten sugarcane production, the adoption of recommended practices, including fungicidal treatments, becomes imperative for sustaining crop health and ensuring economic viability. Therefore, the incorporation of Tebuconazole 50 WP at 0.1% in integrated disease management schedules emerges as a viable strategy for combating sett-transmitted sugarcane smut effectively.

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