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AN IDM APPROACH TO IMPROVE RATOONABILITY OF SUGARCANE CROP IN KP PROVINCE, PAKISTAN

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Abstract

An integrated disease management (IDM) approach was applied for the control of *Fusarium oxysporum*, *Fusarium moneliforme* and *Xylaria hypoxilon* that produce phytotoxic substances responsible for the deterioration of ratoon crop of sugarcane. All components of IDM i.e., Aspergo Pak, Penecillium and Trick Pak together reduced the disease intensity (0.16%) that resulted the highest cane height (3.49 m), cane (81.25 tons ha^{-1}) and sugar (9.95 tons ha^{-1}) yield. The Tricho Pak alone has significantly controlled all three diseases responsible for ratoon crop failure in sugarcane.

Introduction

Sugarcane (Saccharam hybrid) belongs to the grass family Graminae and is grown as a cash crop throughout the world including Pakistan. In Khyber Pakhtunkwa (KP) Province sugarcane is particularly grown in Peshawar Valley due to the most suitable agro-climatic conditions and the availability of crushing facilities in the region. In KP Province, area under cultivation of sugarcane is 1.05 million ha with production of 47 million tones (MINFAL, 2008-09) Inspite of all major efforts rendered by relevant agencies the cane yield in the Province has not yet reached to the level as expected. One important reason for such low yield is the failure of ratoon crop. This yield decrease in ratoon crop of sugarcane is a significant problem world wide. Yield decline of monoculture sugarcane in Taiwan is closely related to insect injury, soil borne pathogens, poor germination and stunted growth of ratoon cane (Min-Muh Kao *et al*., 1989). The imbalance of soil fungi could lead to the predominance of *Fusarium oxysporum* and *Xylaria hypoxilon*, producers of phytotoxic substances, which might be responsible for the poor growth of sugarcane. Insects and the fungi affect tissue in a ratio of 1:16 causing sucrose inversion as 7 and 95% in cane ratoon crop. The sucrose inversion due to the fungi represented 93% of the total damage and the remaining 7% were due to direct damage caused by insect (Nakano *et al*., 1998).

Filter cake was found valuable and comparatively an economical source of macro-nutrients to sugarcane ratoon additionally providing micro elements, 32% organic matter and 6% sulphur which would ameliorate and maintain soil health (Abdul Razzaq, 2001). In India, trash mulching has been found to have improved ratooning in sugarcane. Trash removal and stubble shaving recorded an increased cane and sugar yield as compared to trash removal and no stubble shaving (Nasir & Giridharan, 2000). The objective of the present research was to improve ratoonability of sugarcane crop in KPK Province using IDM approach.

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Materials and Methods

I. a. Screening, isolation and identification of causal organism(s): The diseased stubbles from ratoon fields of sugarcane were collected for identification and isolation of true pathogens responsible for ratoon failure in KPK Province. The stubbles were brought into the Plant Pathology Laboratory at Sugar Crops Research Institute, Mardan for taking culture on different media viz., Potato Dextrose Agar (PDA), Cerelose Ammonium Nitrate (CAN) medium and Corn meal (CMPPP) media for identification of true pathogen(s) in sugarcane crop.

Small amount of tissues were removed from the advanced portion of the lesion using sterile scalper. These tissues were surface sterilized for 3 minutes in 1:10 dilution of chlorox (Sodium Hypo Chloride, Commercial Bleach). After rinsing in distilled water, the tissues were chapped with a sterile scalper in few drops of distilled water in Petri dish. After 2-3 min., the macerate was streaked on to the medium to obtain the pure culture of the organism.

b. Pathogenicity test and completion of Koch's Postulates: A mass of cells of the fungus was removed from slant culture. Cells were transferred to 250ml flasks containing 50ml of liquid PDA medium and were shaken for five minutes. After 24 hr 1ml of the suspension was taken and added to a fresh flask of medium and was thoroughly mixed. After incubation for 4-6 hr the inoculum was cultured on PDA medium at 28^{o}C for 2-3 weeks. The growth was removed with sterile spatula and re-suspended in distilled water. Single nodes of stem cuttings of known susceptible sugarcane cultivar NCO-310 were inoculated by immersing the fresh cut surfaces into the inoculum before planting. The control cuttings were immersed only in distilled water. The treated sets were planted in earthen pots at Sugar Crops Research Institute, Mardan. The symptoms developed on the inoculated canes were compared with the original symptoms. The organism was re-isolated and cultured on PDA medium in order to complete the Koch's postulates.

II. Integrated Disease Management (IDM) Techniques

a. Cultural and mechanical control (T1&T2): All the cultural and Mechanical components i.e., deep ploughing, leveling and recommended dose of cane seed (9844kg ha^{-1}), balance fertilizer (4 bags Urea, 2 bags DAP and 2 bags Potash), press mud and farm yard manure were applied. Frequent irrigations (18-20) were done for the normal growth of cane crop. Two to three times shaving of stubbles was done to avoid stubbles failure. The rouging of the insect pests and disease attacked plants was done regularly. Other cultural practices i.e., hoeing and weeding were done as usual.

b. Chemical control (T3): Topsin M 45 @ 500 g/acre was sprayed on stubbles in ratoon crop fields for the control of *Fusarium moneleforme*, *Fusarium oxysporum* and *Xylaria hypoxilon* responsible for ratoon failure in sugarcane crop.

i. IDM model T1 + T2 + T3
ii. Cultural + Mechanical (T4)
iii. Cultural + Chemical (T5)
iv. Cultural + Mechanical (T6)
v. No treatment + Chemical (T7, T8)

III. Biological control: The experiment was laid out at Sugar Crops Research Institute, Mardan. The earthen pots were loaded with infected soil where the cane crop was attacked by the disease. The stubbles of the plant crop were uprooted from the harvested cane field and replanted in the loaded earthen pots. The inoculum was prepared in Sugar Crops Pathology Laboratory and applied to the loaded earthen pots to confirm the availability of the pathogens. Similarly compost of various fungi i.e., Aspergo Pak, Tricho Pak and Penicillium was prepared and applied @ 50 g earthen pot^{-1} alone and in combination. The following ingredients were used for the preparation of compost:

1. Aspergo Pak or Tricho Pak or Penicillium 250g
2. Wheat Straw broken (Bhosa) 20g
3. Fine soil 60g
4. Urea 3kg

Ingredients were mixed accordingly and applied to the loaded earthen pots. The treatments were followed as under:

S. No.	Treatments	Dose earthen pot^{-1}
1.	Compost of Aspergo Pak alone	50.0g
2.	Compost of *Penicillium* alone	50.0g
3.	Compost of Tricho Pak alone	50.0g
4.	Compost of Aspergo Pak + *Penicillium*	25.0g
5.	Compost of Aspergo Pak + Tricho Pak	25.0g
6.	Compost of *Penicillium* + Tricho Pak	25.0g
7.	Compost of Aspergo Pak + Tricho Pak + *Penicillium*	12.5g
8.	No treatment	

The culture used in the experiment was obtained from Dr. Mohammad Tahir, Plant Pathologist, Ayub Agriculture Institute, Islamabad.

The trial comprised of eight treatments including check. The trial was conducted in Randomized complete block design (RCBD) with three replications. One earthen pot was used for one treatment. The disease data was recorded on fortnightly basis.

Results

Pathogens i.e., *Fusarium moneliforme* and *Xylaria hypoxilon* responsible for deterioration ratoon crops of sugarcane were isolated and identified at the Plant Pathology Laboratory of Sugar Crops Research Institute (SCRI) Mardan.

The lowest disease intensity of 0.16% was recorded when Topsin M was applied alone (T3) and in combination (T7), followed by T5 and T6 (Table 1). The highest disease attack of 10.16% was recorded in check where no treatment was given. The mean disease incidence was noted as 1.93%. Similarly the highest cane height of 3.49 m was recorded in T7, followed by 3.40 m with an average of 2.4 m. The lowest cane height of 1.95 m was recorded in control. The interaction between the treatments was non significant at 5% LSD level but highly significant when compared with control. The highest cane yield of 81.25 tones ha^{-1} was obtained from T7 where all the components of IDM were put together followed by T6 (76 tons ha^{-1}) with an average of 66.67 tons ha^{-1}. The lowest cane yield of 60.42 tons ha^{-1} was recorded for check. The interaction between the treatments is highly significant as 5% LSD level. Similarly the highest sugar yield of 9.95 tons ha^{-1} was obtained from T7, followed by 9.27 tons ha^{-1} from T6 with mean of 8.77 tons ha^{-1}. The lowest sugar yield of 7.32 tons ha^{-1} was recorded for check.

Table 1. Effect of various treatment combination of disease intensity, sugarcane growth and yield parameters.

Treatments	Disease intensity (%)	Cane height (m)	Cane yield (tons ha^{-1})	CCS (%)	Sugar yield (tons ha^{-1})
T1- Cultural control (CuC)	1.16	3.40 AB	70.75 D	12.25	8.66 D
T2- Mechanical control (MeC)	1.16	3.37 B	69.50 D	12.15	8.44 D
T3- Chemical control (ChC)	0.16	3.34 B	73.25 C	12.25	8.97 C
T4- CuC + MeC	1.33	3.37 B	70.50 D	12.20	8.60 D
T5- CuC + ChC	0.66	3.34 BC	73.75 C	12.15	8.96 C
T6- MeC + ChC	0.66	3.28 BC	76.00 B	12.20	9.27 B
T7- CuC + MeC + ChC	0.16	3.49 A	81.25 A	12.25	9.95 A
T8- Check	10.16	1.95 D	60.42 E	12.12	7.32 E
Mean	**1.93**	**3.19**	**71.92**	**12.19**	**8.77**
LSD 5%		**0.299**	**O.7669**		

Table 2. Disease status of sugarcane under various biocontrol treatments.

S. No.	Treatment	Total plants	Healthy	Diseased	Diseased intensity (%)	Grading
1.	Aspergo Pak (AP) alone @ 50g	20	12	8	40	E
2.	*Penicillium* (*P*) alone @ 50g	20	10	10	50	G
3.	Tricho Pak (TP) alone @ 50G	20	19	1	5	A
4.	AP + *P* @ 25g each	20	11	9	45	F
5.	AP + TP @ 25g each	20	16	4	20	B
6.	*P* + TP @ 25g each	20	15	5	25	C
7.	AP + *P* + TP @ 12.5g each	20	14	6	30	D
8.	No treatment	20	2	18	90	H

Tricho Pak alone (T3) significantly controlled *Fusarium* and *Xylaria* in controlled conditions in the earthen pots and noted the disease intensity of 5% followed by (T5) where combined treatment of Aspergo Pak + Trich Pak and recorded the disease intensity of 20%. The highest disease intensity of 90% was recorded in check (T8) where no treatment was given. Aspergo Pak and *Penicillium* have shown no response in controlling the disease responsible for ratoon failure in sugarcane crop (Table 2).

Discussion

Identification of the true pathogens i.e., *Fusarium oxysporium*, *Fusarium moneliforme* and *Xylaria hypoxilon* in the Plant Pathology Laboratory at SCRI, Mardan confirmed as per procedure of Watanable *et al*., (1974), Hsieh (1980), Kao *et al*., (1984) and Ming-Muk *et al*., (1989). By adoption of integrated pest management techniques, it was observed that all the pathogens responsible for the deterioration of ratoon crops of sugarcane were effectively controlled. As a result, an increase in cane and sugar yield ha^{-1} was materialized (Kao *et al*., 1984; Nakano Soares, 1998; Abdul Raziq, 2001 and Arif *et al*., 2001). Similarly the Tricho Pak (Biological control) effectively controlled the diseases. However, the application of AspergoPak and *Penicillium* were not up to the mark (Wanatable, 1974; Atwal, 1976; Ming- Muk, *et al*., 1989 and Nasir *et al*., 2000).

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