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Effect of fungicides, botanicals, bioagents and Indigenous Technology Knowledge (ITK's) on germination of urediniospores of *Puccinia sorghi in vitro*

Utpal Dey[1]*, S. I. Harlapur[1], D. N. Dhutraj[2], A. P. Suryawanshi[2], G. P. Jagtap[2], K. T. Apet[2], S. L. Badgujar[2], V. M. Gholve[2] , H. N. Kamble[2], D. P. Kuldhar[2] and S.S. Wagh[2]

[1]Department of Plant Pathology, University of Agricultural Sciences, Dharwad-580005, Karnataka, India.
[2]Department of Plant Pathology, Marathwada Agricultural University, Parbhani-431402, Maharashtra, India.

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Tebuconazole 250 EC (4.78% urediniospores germination) was found to be significantly superior among the eight systemic fungicides evaluated *in vitro* condition against *Puccinia sorghi* at different concentrations. Among the non-systemic fungicides Mancozeb + Phyton (7.24% urediniospores germination) was found to be significantly superior followed by Mancozeb (24.44% urediniospores germination) at different concentrations screened *in vitro*. The fungicides revealed higher efficacy with the increase in concentration levels. Among the botanicals tested, Neemazol F5% caused significantly less percent spore germination (6.55%) followed by Nimbicidine (6.83%) at different concentrations and *Trichoderma harzianum* at 10^8 spores/ml was recorded significantly less percent germination (31.07%) followed by *Bacillus subtilis* (43.42%) and *Pseudomonas flourescens* (53.39%) evaluated *in vitro* condition against *P. sorghi* at different concentrations. Jeevamruta at 20% concentration caused significantly less percent germination (22.69%) followed by Panchyagavya at 20% (33.67%).

Key words: Botanical, bioagent, common rust, fungicide, Indigenous Technology Knowledge (ITK's), *in vitro* bioassay, maize, *Puccinia sorghi*.

INTRODUCTION

Maize (*Zea mays* L.) is one of the most important cereal crops that expands its adaptation from very high north and south latitudes in temperate areas, through subtropical and tropical environments in north and south of the equator. Maize is one of the most important cereal crops in the world, grown in an area of 140 million hectares. Among the cereals, maize is wide spread crop next to wheat and rice in the world and ranks fourth after rice, wheat and sorghum. In India, it is consumed both as food and fodder crop. It has got immense potential and hence called as 'Miracle crop' and also called as 'Queen of cereals'. In the future, maize demand is expected to increase, mainly because it is used by larger population as human food and due to its increased consumption as feed in poultry for animal protein. Besides multiple uses and several products derived from maize crop, it can contribute to diet diversification and improved nutrition in human beings through exploitation of quality protein maize (Singhal, 2003).

As many as 18 foliar diseases are reported to occur in

*Corresponding author. E-mail: utpaldey86@gmail.com.

India, but common rust of maize caused by *Puccinia sorghi* Schweinitz is considered to be the major disease. Common rust of maize appears in severe form in several areas of the country, resulting in grain yield reductions (Sharma et al., 1982; Dey et al., 2012). The disease appears from the early stages of crop growth and causes long lasting effect on the crop growth and yield potential of the crop if proper management is not adopted in time. In India the disease has become a potential threat to maize cultivation. In north India, it appears every year and is most damaging and widely prevalent and reduces the quality and quantity. Many investigators extensively studied chemical control of rust disease using fungicides (Mueller et al., 2005); plant extracts (El-Kazzaz et al., 2003; Mahmoud et al., 2004) and plant growth regulators (Fayza et al., 2004; Zalat et al., 2004). Great attention has been paid to use an integrated disease management approach for controlling sugar beet rust disease through utilization of resistant cultivars, minimizing fungicides application and looking for alternative options to decrease the human health hazards (Ramadan and Nassar, 2005). There is less of information available on chemical control of common rust of maize in field trails. However, it is essential to verify the bio-efficacy of existing and new chemicals *in vitro* and provide *in vivo* schedule of different systemic, non-systemic fungicides, botanicals, bio-agents and Indigenous Technology Knowledge (ITK's) that are recently developed for the effective management and recommendation to the growers. In view of this, different botanicals and bio-agents need to be explored for their effectiveness and to fit in with the management schedule of the disease suitably. Keeping above points in mind and considering the magnitude of

common rust of maize and its resultant losses the present investigation was undertaken with an aim to screen out most efficient fungicides, botanicals, bio-agents and Indigenous Technology Knowledge (ITK's) against *P. sorghi.*

MATERIALS AND METHODS

The present investigations on *in vitro* bioassay of different fungicides, botanicals, bio-agents and indigenous technology knowledge (ITK's) were carried out using Completely Randomized Design (CRD) at College of Agriculture, University of Agricultural Sciences, Dharwad, Karnataka, India during *Autum* season, 2009-10. Various fungicides, botanicals, bioagents and ITK's were evaluated *in vitro* condition by using spore germination technique against *P. sorghi* at 5, 10 and 20% concentrations of botanicals viz. Neem oil, Nimbicidine, Soldier, Sainik, Achook, Wanis, Neemazol F 5%, Neemazol F 1%, Discheck and 5, 10 and 20% concentrations of ITK's viz. Cow urine, cow milk, butter milk, Panchyagavya (cow dung - 7 kg, cow ghee - 1 kg, cow urine - 10 L, water - 10 L, cow milk - 3 L, cow curd - 2 L, tender coconut water - 3 L, jaggery - 3 kg and well ripened poovan banana – 12 nos.), Vermiwash (watery extract of compost, the wash (celomic fluid) of earthworms present in the medium), Jeevamruta (desi cow dung 10 kg, desi cow urine 5 to 10 L, jaggery 2 kg, flour of any pulse 2 kg and water 200 L) and 0.025, 0.05 and 0.025, 0.05 and 0.1% of systemic fungicides viz. Hexaconazole, Propiconazole, Taboconazole, Penconazole, Triadimefon, Difenaconazole and Myclobutanol and 0.1, 0.15 and 0.25% concentration of non-systemic fungicides viz. Mancozeb, Zineb, Wetable sulphur and combination products Hexaconazole + Zineb, Mancozeb + Phyton were prepared under aseptic conditions. The urediniospores suspension was prepared separately in sterile water to obtain 4×10^8 urediniospores per ml. Then a drop of a spore suspension was mixed with one drop of botanicals, ITK's and fungicidal solution in a cavity slide to achieve the required concentration. In each treatment three replications were maintained. Slides were incubated at room temperature (25± 1° C) for 24 h. The observation on spore germination was recorded 24 h after incubation under microscope at 40 X magnification. An untreated control treatment was maintained with sterile water. Percent urediniospores germination was calculated by following formula.

Percent spore germination (PG) = A/B × 100

Where, A = No. of urediniospores germinated; B = No. of urediniospores observed.

Fourteen fungicides consisting of eight systemic, four non-systemic and two combi- products were assayed for their efficacy against *P. sorghi* under *in vitro* conditions. The systemic fungicides were tested at 0.025, 0.05 and 0.1% concentration, whereas rest of the fungicides was tested at 0.1, 0.15 and 0.25% concentration.

Plant based pesticides are relatively cheaper, safe and non hazardous and they can be used easily and successfully against the plant pathogenic fungi. The present investigation was aimed to study the anti- fungal activity of some plant extracts. The following plant extracts were evaluated at 5, 10 and 20% concentration.

The fungal biocontrol agents, viz., *Trichoderma harzianum* and bacterial antagonists *Pseudomonas fluoroscens* and *Bacillus subtilis* collected from Department of Plant Pathology, College of Agriculture, University of Agricultural Sciences, Dharwad were evaluated against *P. sorghi*. These bio-control agents were screened under *in vitro* conditions against *P. sorghi* for their antagonistic activity. The cavity slides were subsequently incubated at 25±1°C. Each treatment was replicated eight times. The percent germination of urediniospores over control was calculated.

Various ITK's were evaluated *in vitro* condition by spore germination technology against *P. sorghi* Schw. at 5, 10 and 20% concentrations. The urediniospores suspension was prepared separately in sterile water to obtain 4×10^8 urediniospores per ml. Then a drop of a spore 4×10^8 suspension was mixed with one drop of ITK's solution in a cavity slide to achieve the required concentration. In each treatment 8 replications were maintained. Slides were incubated at room temperature (25 ±1° C) for 24 h. The observation on spore germination was recorded 24 h after incubation under microscope at 40 x magnification. A control treatment was be maintained with sterile water. Percent conidial germination was calculated as mentioned in case of fungicides evaluation.

RESULTS AND DISCUSSION

Efficacy of eight systemic, four non-systemic and two combiproduct fungicides were tested as explained in material and methods. Results on effect of different fungicides on the germination of *Puccinia sorghi* are presented in Tables 1 and 2. It was observed that fungicides showed significant differences in their efficacy to urediniospores germination of *P. sorghi*. All the fungicides tested gave significantly less percent spore germination over control (Plates 1 and 2). Among the systemic fungicides, Tebuconazole 250 EC found highly

Table 1. *In vitro* evaluation of systemic fungicides against *Puccinia sorghi.*

Systemic fungicide	Urediniospores germination (%)			
	0.025%	0.05%	0.1%	Mean
Hexaconazole	28.96(23.46)	21.76 (13.75)	21.09(12.96)	24.13*(16.72)**
Propiconazole	31.62(27.50)	23.13(15.44)	20.07(11.79)	25.27(18.24)
Tebuconazole	12.92(5.00)	12.72(4.85)	12.23(4.49)	12.62(4.78)
Penconazole	35.45(33.67)	30.38(25.60)	20.63(12.42)	29.25(23.89)
Triadimefon	42.31(45.35)	35.85(34.33)	26.87(20.44)	35.27(33.37)
Difenconazole	26.64(20.12)	25.88(19.07)	18.48(10.06)	23.90(16.42)
Myclobutanol	41.77(44.40)	35.94(34.47)	29.01(23.53)	35.73(34.13)
Azoxystrobulurin	35.45(33.67)	25.88(19.07)	20.63(12.42)	27.77(21.72)
Control	80.74(97.43)	80.49(97.29)	80.47(97.28)	80.56(97.33)
Mean	37.32(36.73)	32.45(29.32)	27.72(22.82)	32.72(29.62)

Comparing the means of	SEm±	CD at 1%
Treatment (A)	0.11	0.41
Concentration (B)	0.20	0.76
A X B	0.35	1.32
CV%	-	2.34

* Arcsine transformed values; **Data in parenthesis are original values.

Table 2. *In vitro* evaluation of non systemic fungicides and combi-products against *P. sorghi.*

Treatment	Urediniospores germination (%)			
	0.1%	0.15%	0.25%	Mean
Mancozeb	37.94(37.82)	31.05(26.63)	17.33(8.88)	29.62*(24.44)**
Zineb	41.53(43.98)	35.46(33.68)	21.18(13.06)	33.35(30.24)
Kresoxim-methyl	46.62(52.87)	38.12(38.14)	30.38(25.60)	38.55(38.87)
Wettable sulphur	41.03(43.13)	29.80(24.71)	25.88(19.07)	32.24(28.97)
Mancozeb + Phyton	16.13(7.72)	15.69(7.32)	14.97(6.68)	15.60(7.24)
Hexaconazole 4% + Zineb 68% WP	42.09(44.96)	32.63(29.09)	19.88(11.57)	32.28(28.54)
Control	80.74(97.43)	80.49(97.29)	80.47(97.28)	80.56(97.33)
Mean	43.73(46.85)	37.61(36.69)	30.01(26.02)	37.46(36.52)

Comparing the means of	SEm±	CD at 1%
Treatment (A)	0.14	0.44
Concentration (B)	0.26	0.79
A X B	0.39	1.40
CV%		2.02

* Arcsine transformed values; **Data in parenthesis are original values.

effective at all the concentrations tested. Significantly lowest urediniospores germination was recorded in Tebuconazole 0.1% (4.49%) followed by Difenconazole 0.1% (10.06%), Propiconazole 0.1% (11.79%), Mancozeb 0.25% (12.38%) Penconazole 0.1% (12.42%) and Azoxystrobulurin 0.1% (12.42%) as compared to control (97.33%). Data indicated that Tebuconazole (0.1%) showed least percent spore germination (4.49%), which is statistically on par with Difenconazole, Propiconazole, Mancozeb, Penconazole and Azoxystrobulurin (Figures 1 and 2).

Significantly maximum spore germination was observed in Triadimefon at 0.025 percent (45.35%) and Myclobutanol at 0.025 percent (44.40%) indicating their ineffectiveness. Among the systemic fungicides, Tebuconazole 0.1% (4.49%) gave less percent germination followed by Difenconazole at 0.1% (10.06%). Of the four non-systemic fungicides, the most effective ones were Mancozeb at 0.25% (12.38%) followed by Zineb at 0.25% (13.01%).

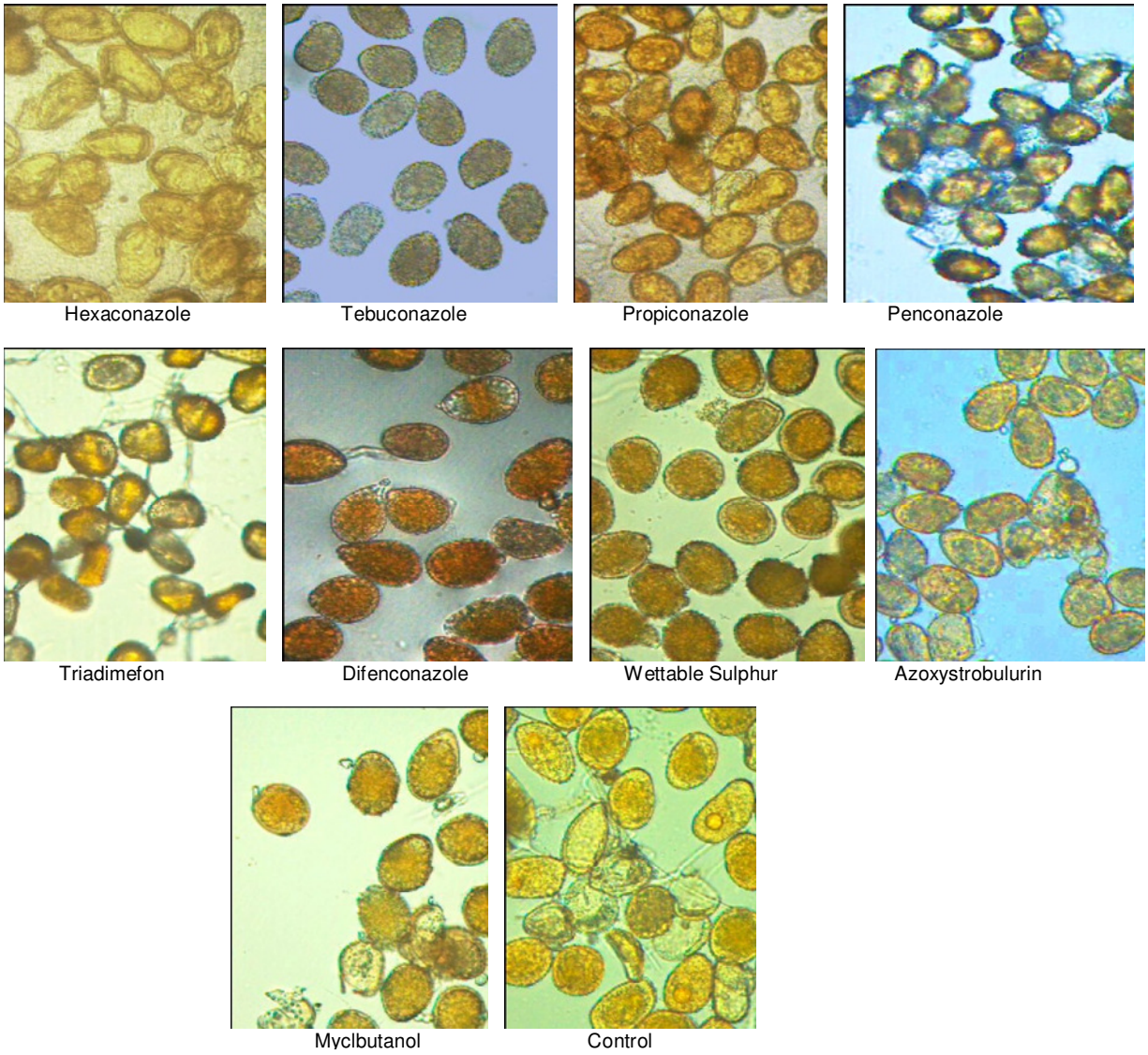

Plate 1. *In-vitro* evaluation of systemic fungicides.

Antifungal activity of 14 botanicals was assayed as mentioned in the material and methods. The data on effect of plant extracts on the percent germination of urediniospores is presented in Table 3. The data revealed that significantly lower percent germination of urediniospores was observed in respect of all the botanicals tested. Among the botanicals tested, Neemazol F5% at 20% concentration caused significantly less percent spore germination (5.93%) followed by Nimbicidine at 20% (5.93%), while Wanis at the rate of 5% and Neemgold at 5% were least effective (35.94 and33.67% germination, respectively). In the present study, Neemazol F5% at 20% has shown considerable promise in reducing the percent germination of the pathogen (Plate 3 and Figure 3). Ganapathy and Narayanaswamy (1990) found that neem oil from *Azaridicta indica* and leaf extract of *Nerium odorum* solution reduced the incidence of rust. Adiver et al. (1995) evaluated aqueous neem leaf extract under field condition for control of late leaf spot and rust diseases of groundnut and showed that the aqueous neem leaf extract preparations had effect on reducing the disease and increased yield.

Three biological control agents were screened under *in vitro* conditions against *P. sorghi* for their antagonistic activity by using percent germination method as explained in material and methods. It is apparent from the data presented in Table 4 that, the antagonistic fungi and bacteria recorded urediniospores germination ranging from 27.37 to 61.04%. *Trichoderma harzianum* recorded significantly less percent germination (27.37%) followed by *Bacillus subtilis* (33.85%) and *Pseudomonas flourescens*

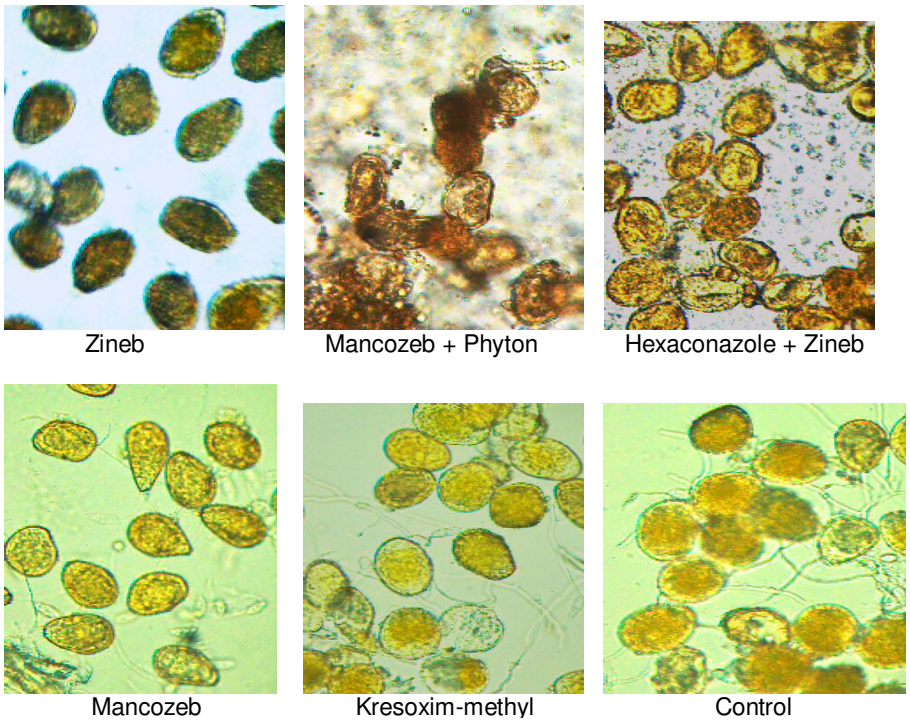

Plate 2. *In-vitro* evaluation of non systemic fungicides and combi-products.

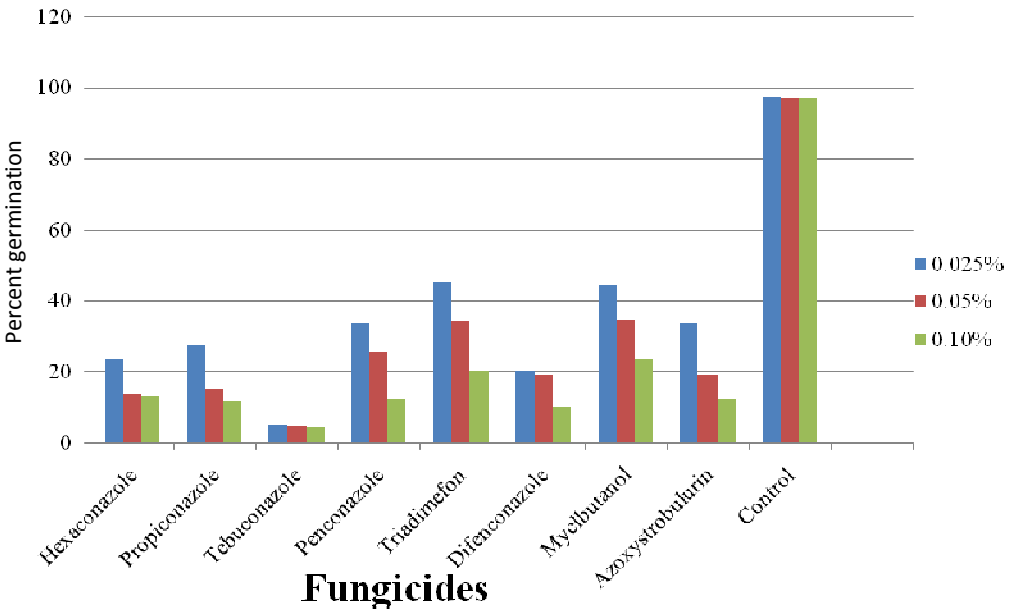

Figure 1. *In vitro* evaluation of systemic fungicides.

(46.20%) at 20% concentration (Plate 4 and Figure 4). *Pseudomonas fluorescens* was found to be least effective (61.04%) at 5% concentration as compared to control (97.27%). Mahamood et al. (1995) noticed that *Trichoderma* sp., *Aspergillus* sp. and *Cladosporium* sp. and some unidentified fungi were highly effective in inhibiting mycelia growth and sporulation of *H. turcicum* causing leaf blight of maize. Ramachandra (2000) evaluated antagonists against *E. hawaiiensis in vitro* and found that *T. viride* and *T. harzianum* reduced the growth and sporulation significantly.

Antifungal activity of six ITK's was assayed as mentioned

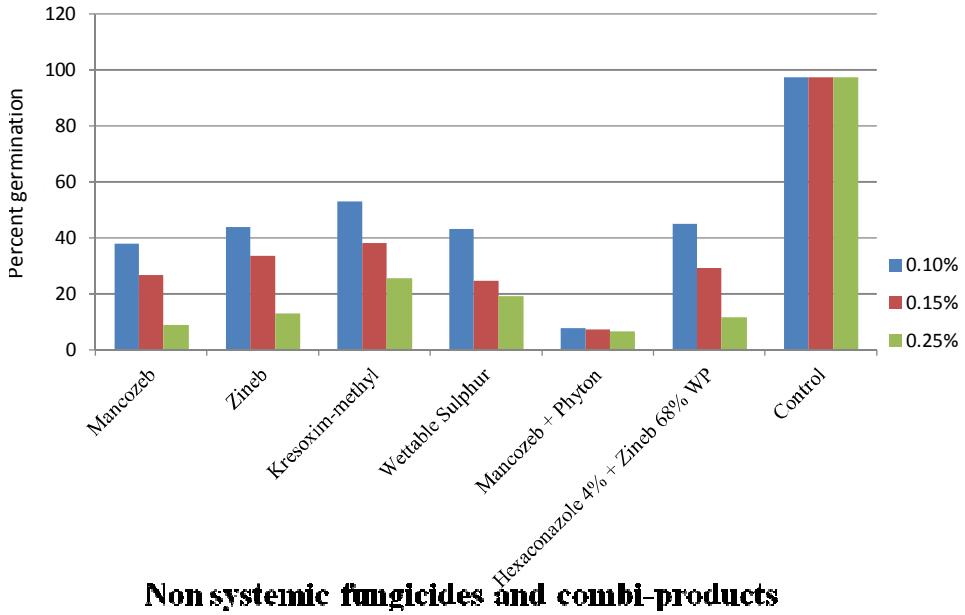

Figure 2. *In vitro* evaluation of non systemic fungicides and combi-products.

Table 3. *In vitro* evaluation of commercial botanicals against *P. sorghi.*

Botanical	Urediniospores germination (%)			
	5%	10%	20%	Mean
Neemgold	35.45(33.67)	28.20(22.35)	25.88(19.07)	30.28*(25.44)**
Vijayneem	19.71(11.38)	18.49(10.07)	16.81(8.37)	18.37(9.94)
Fire	28.21(22.36)	25.58(18.66)	23.13(15.44)	25.70(18.82)
Soldier	26.14(19.42)	21.67(13.65)	18.45(10.02)	22.26(14.36)
Sainik	20.81(12.63)	18.95(10.55)	18.01(9.57)	19.29(10.92)
Achook	25.78(18.93)	21.18(13.06)	20.45(12.22)	22.58(14.76)
Wanis	36.82(35.94)	33.15(29.93)	32.76(29.31)	34.27(31.76)
Neemazol F 1%	17.59(9.14)	17.43(8.98)	16.13(7.72)	17.06(8.61)
Neemazol F5%	15.51(7.16)	14.83(6.56)	14.09(5.93)	14.82(6.55)
Dischecк	23.23(15.57)	19.54(11.20)	15.76(7.38)	19.71(11.38)
Phyton	19.71(11.38)	18.95(10.55)	18.63(10.21)	19.09(10.71)
Pongamia	22.50(14.65)	20.93(12.77)	17.89(9.44)	20.51(12.28)
Cristol	18.48(10.06)	17.89(9.44)	17.32(8.87)	17.91(9.46)
Nimbicidine	15.93(7.54)	15.36(7.02)	14.09(5.93)	15.14(6.83)
Control	80.74(97.43)	80.49(97.29)	80.47(97.29)	80.56(97.33)
Mean	21.66(15.32)	19.45(18.81)	23.32(17.12)	25.17(19.28)

Comparing the means of	SEm±	CD at 1%
Treatment (A)	0.23	0.84
Concentration (B)	0.10	0.38
A X B	0.39	1.46
CV%	-	2.70

*Arcsine transformed values; **Data in parenthesis are original values.

in the material and methods. The results (Table 5) revealed that significantly less percent urediniospores germination was observed in respect of all the ITK's tested (Plate 5). Among the Indigenous Technology

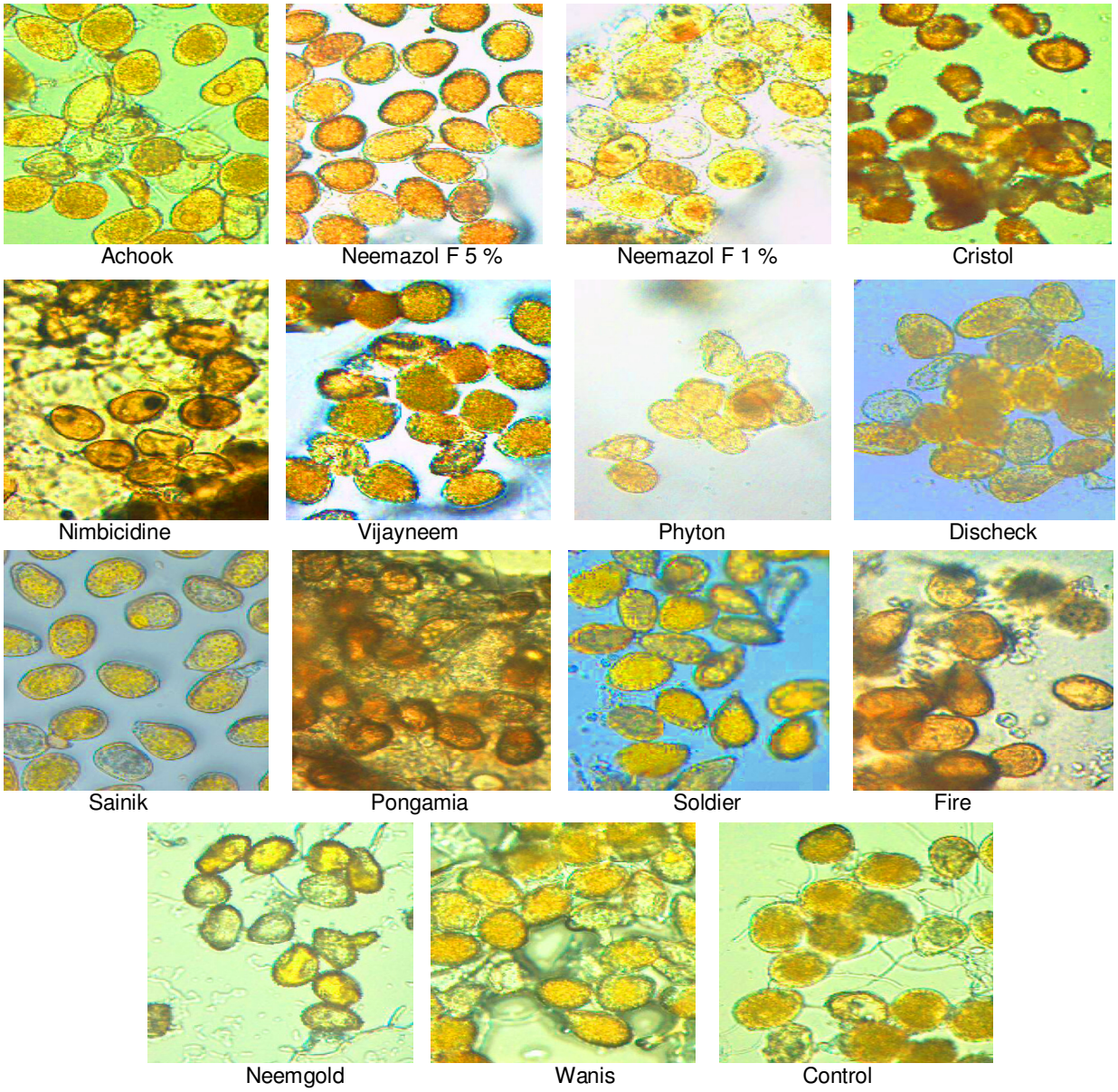

Plate 3. *In vitro* evaluation of botanicals.

Knowledges tested, Jeevamruta at 20% concentration caused significantly less percent germination (22.69%) followed by Panchyagavya at 20% (33.67%), while cow urine (5%), cow milk (5%) and Butter milk (5%) were least effective (84.56 and 76.11 % germination, respectively). Cow urine, cow milk, butter milk and vermiwash found least effective which have recorded higher urediniospores germination. In the present study, Jeevamruta at 20% has shown considerable promise in reducing the percent germination of the pathogen (Figure 5). Sumangala and Patil (2007) found that Panchagavya – an organic formulation evaluated *in vitro* for its antifungal activity against *Curvularia lunata* in rice, which found to be dominant pathogen in causing grain discoloration. Panchagavya resulted in 86.30 percent inhibition of mycelial growth and 95.9% of spore germination of *Curvularia lunata*. Seed treatment with panchagavya further enhanced the seed germination with 90.7% and vigour index of 1036.

Bioassay of various fungicides indicated that Mancozeb (0.25%) was found to be the most effective non-systemic fungicide in reduction of percent germination (12.38%) of urediniospores s. The next best non-systemic fungicide was zineb (0.25%) with 13.01% germination. Among the systemic group of fungicides tested, Tebuconazole (0.1%) was found to be the best ones which exhibited 4.49% germination. Of the six triazole chemicals included in this study, only Tebuconazole performed excellent.

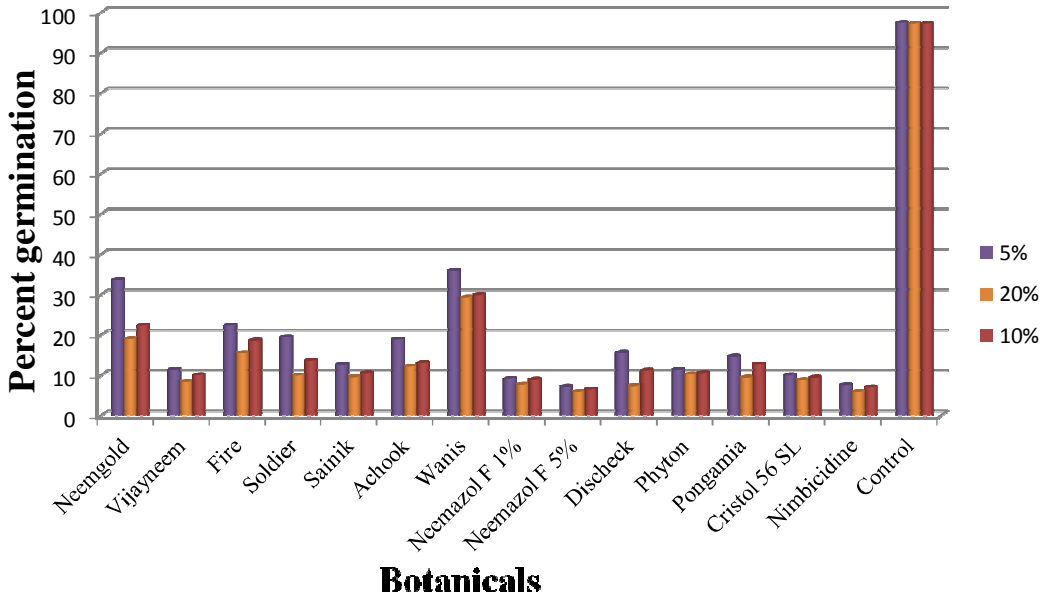

Figure 3. *In vitro* evaluation of commercial botanicals**.**

Table 4. *In vitro* evaluation of bioagents against *P. sorghi.*

Bioagent	Urediniospores germination (%)			
	5%	10%	20%	Mean
Trichoderma harzianum	37.62(37.29)	32.29(28.56)	31.53(27.37)	33.86* (31.07)**
Pseudomonas flourescens	51.36(61.04)	46.66(52.93)	42.80(46.20)	46.92(53.39)
Bacillus subtilis	46.60(52.83)	41.30(43.59)	35.56(33.85)	41.20(43.42)
Control	80.28(97.17)	80.53(97.31)	80.55(97.32)	80.46(97.27)
Mean	53.97(62.08)	50.20(55.60)	47.61(51.19)	50.61(56.29)

Comparing the means of	SEm±	CD at 1%
Treatment (A)	0.14	0.33
Concentration (B)	0.12	0.28
A X B	0.25	0.57
CV%	-	0.85

*Arcsine transformed values; **Data in parenthesis are original values.

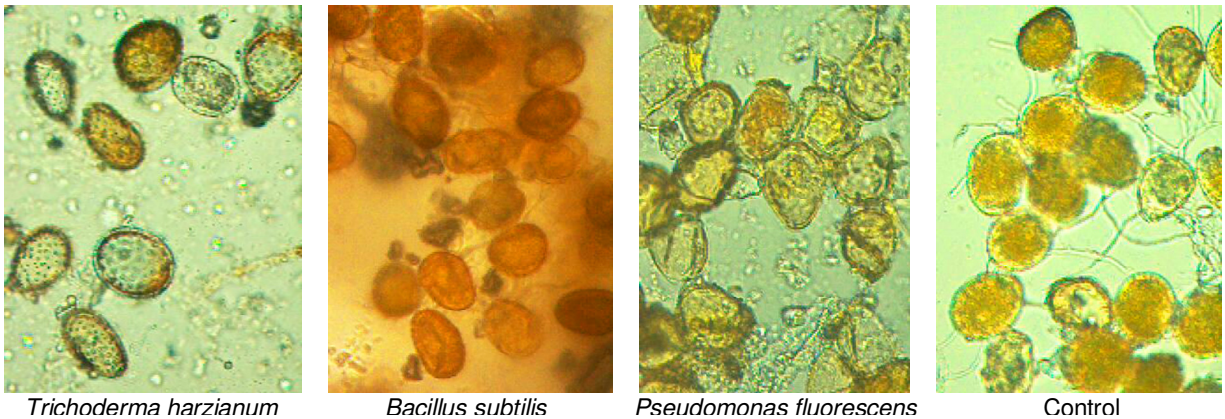

Plate 4. *In-vitro* evaluation of bio-agents.

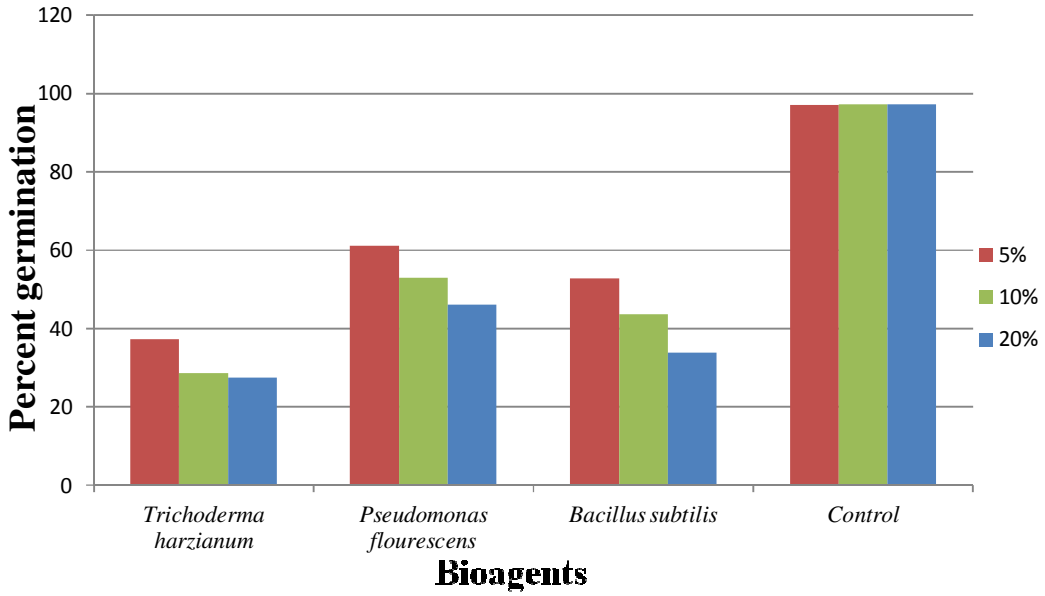

Figure 4. *In vitro* evaluation of bioagents against *Puccinia sorghi*.

Table 5. *In vitro* evaluation of indigenous technology knowledge against *P. sorghi*.

Indigenous technology knowledge	Urediniospores germination (%)			
	5%	10%	20%	Mean
Cow urine	66.84(84.56)	61.83(77.75)	52.44(62.88)	60.02*(75.06)**
Cow milk	61.34(77.04)	52.79(63.47)	49.14(57.24)	54.26(65.92)
Butter milk	60.72(76.11)	55.95(68.69)	52.44(62.88)	56.29(69.23)
Panchyagavya	53.28(64.29)	49.32(57.54)	35.45(33.67)	46.03(51.83)
Vermiwash	58.82(73.24)	55.95(68.69)	52.75(63.40)	55.80(68.44)
Jeevamruta	49.14(57.24)	41.03(43.13)	28.44(22.69)	39.81(41.02)
Control	80.74(97.43)	80.49(97.29)	80.47(97.28)	80.56(97.33)
Mean	61.55(75.70)	56.77(68.08)	50.16(57.15)	56.11(66.98)
Comparing the means of	SEm±		CD at 1%	
Treatment (A)	0.19		0.60	
Concentration (B)	0.10		0.39	
A X B	0.27		1.05	
CV%	-		0.85	

*Arcsine transformed values; **Data in parenthesis are original values.

Triadimefon (0.025%) and Myclbutanol (0.025%) were least effective. The effectiveness of fungicides, Dithane M-45 and Tebuconazole against *P. sorghi* has been reported by Gupta (1978). It is a broad spectrum systemic triazole fungicide with a protective curative and eradicant activity, and the primary mode of action is the inhibition of ergosterol biosynthesis in fungi (Hewitt, 1998). Many light and electron microscope studies have been carried out on the effects of ergosterol biosynthesis-inhibiting (EBI) fungicides on plant pathogenic fungi. EBI fungicides usually cause in fungi marked morphological malformations, irregular cell wall thickening and excessive branching (Kang et al., 2001).

The results indicated that the various phytoextracts tested less percent germination of urediniospores s as compared to control. However, Neemazol F5% at 20% was highly effective which caused significantly less percent germination (5.93%) and was closely followed by Nimbicidine (6.83%). Similar results on antifungal activity of aqueous extracts of different plants have been reported by Ganapathy and Narayanaswamy (1990).

In the present study, besides Neemazol F5%, Nimbicidine and Vijayneem were also fairly effective. The inhibitory action of Neemazol F5% may be due to azadirchitin present in seed kernels which retards the urediniospores germination and activation of the

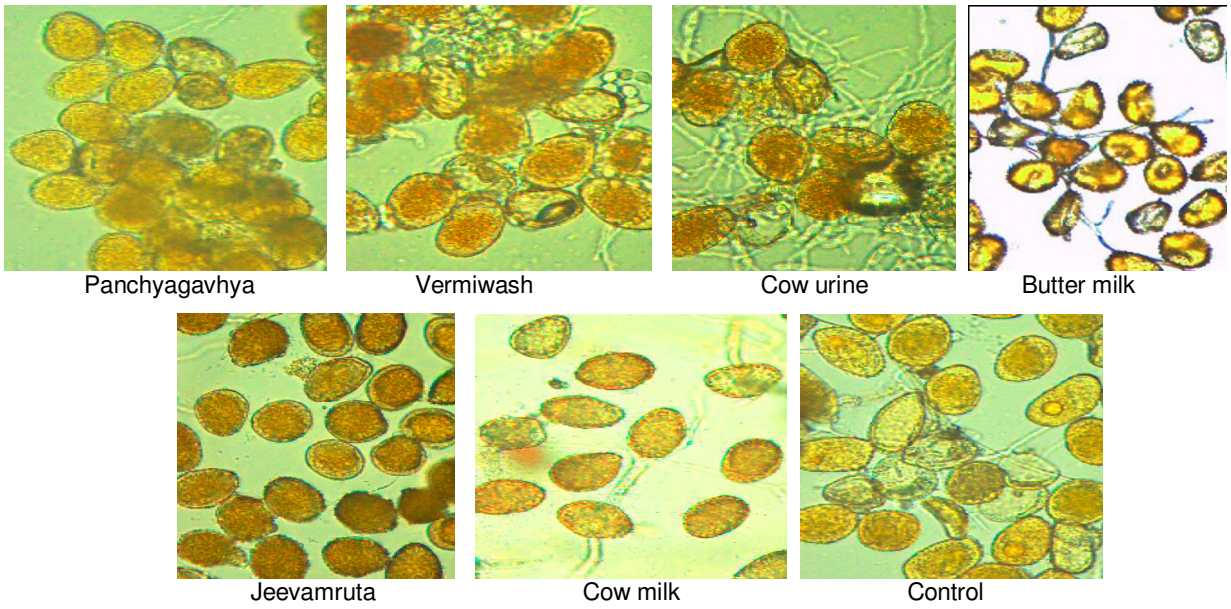

Plate 5. *In-vitro* evaluation of indigenous technology knowledge.

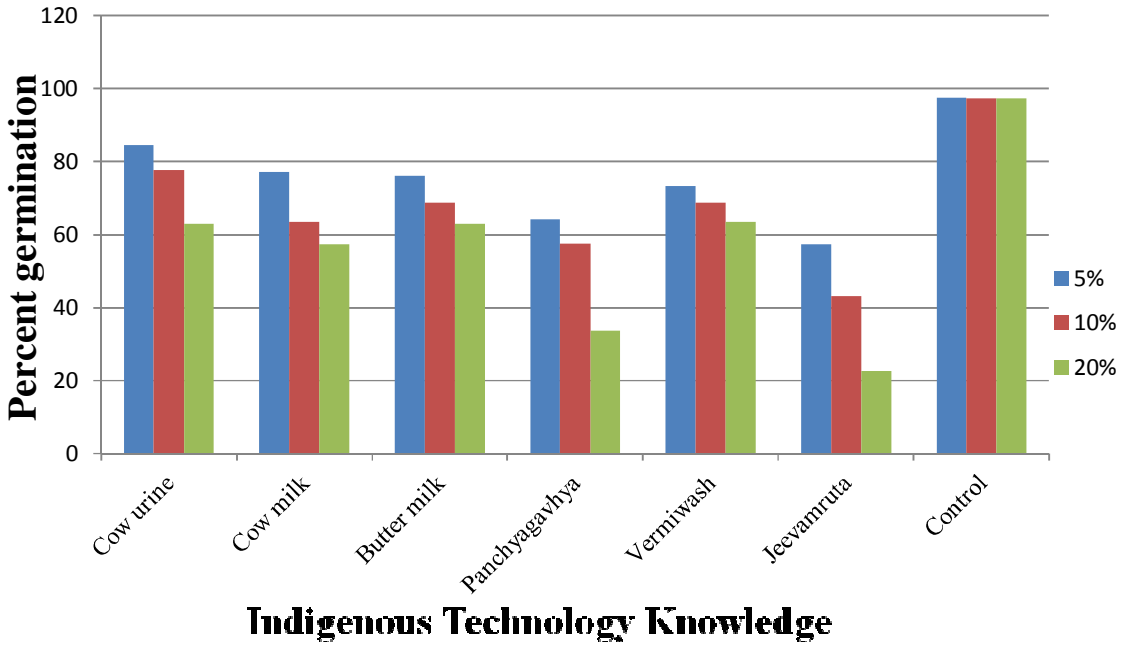

Figure 5. *In vitro* evaluation of Indigenous Technology Knowledge.

pathogen. Therefore it is concluded that neem based botanical product can be use as one of the component of integrated management.

T. harzianum recorded significantly less percent spore germination (27.37%) followed by *Bacillus subtilis* (33.85%). The inhibitory effect of these bio-agents was probably due to competition and / or antibiosis. The antagonism of *T. harzianum* and *T. viride* observed in the present studies is in tune with the findings of Harlapur (2005)

Among the Indigenous Technology Knowledges tested, Jeevamruta at 20% concentration caused significantly less percent germination (22.69%) followed by Panchyagavya at 20% (33.67%), while cow urine (5%), cow milk (5%) and butter milk (5%) were least effective (84.56 and 76.11% germination respectively). Indigenous

Technology Knowledges are having some antifungal activity against urediniospores germination.

Applications of fungicides for the sole purpose of reducing or eliminating spores on plant surfaces would be beneficial in several situations. For example, if plants or propagation materials (e.g., liners, cuttings, etc.) were shipped from a nursery or production facility where a specific rust was known or suspected to be present, a fungicide application immediately before or after shipping could reduce or eliminate inoculums on the plants. Also, if an effective fungicide were available, it could be applied routinely to plants to eliminate the possibility of introducing inoculam of pathogens of quarantine significance.

In fact, most fungicides were used as protectants and others as chemotheraputic agents. Several investigators recorded that the single spray with certain systemic fungicides at the first appearance of the rust disease symptoms on the corn plants reduced the disease incidence when compared with unsprayed controls **(**Sanders and Langston, 2008; Schleicher, 2012). Chaudhary and Chaudhari (2013) reported that propiconazole found the best for inhibition of 86.03% uredospores germination of *P. graminis* f.sp. *tritici* followed by hexaconazole and penconazole with 77.40 and 72.29%, respectively. Jalinder et al. (1986) observed that Dithane M-45 proved to be most effective for inhibition of uredospores germination of *P. graminis* f.sp. *tritici*. Mancozeb and chlorothalonil have been reported superior for the inhibition of uredospores germination of *P. helianthi* (Amaresh and Nargund, 2003). Nagesh et al. (2002) also found the completed inhibition of uredospore germination of *P. helianthi* by propiconazole and hexaconazole were occured at 1000 ppm concentration.

Botanicals did not differ significantly with each other but differed significantly with control. However, neemazole gave better control of common rust as compared to other botanicals. The results of the present study suggest that neem based botanical extracts possess compounds containing antibacterial properties that can potentially be useful to control disease (Kalappanavar et al., 2008).

Trichoderma was significantly differed in managing the common rust of maize as compared to rest of the bioagents. Further, all the three bio-agents were significantly superior over control. The antagonism of *Trichoderma* spp. against many fungi is mainly due to production of acetaldehyde compound (Dennis and Webster, 1971). This may also be the reason for its antagonistic effect on *P. sorghi*. Jeevamruta was significantly reduced the common rust infection as compared to other ITK's. Presence of naturally occurring beneficial microorganisms predominantly bacteria, yeast, actinomycetes, photosynthetic bacteria and certain fungi were detected in organic liquid manures (Swaminathan, 2005). Sreenivasa et al. (2010) reported that Jeevamruta contains phosphobacteria, Actinomycetes and Free living N2-fixers. Neemazol, Trichoderma and Jeevamruta can be used to manage of *P. sorghi* instead of fungicides which will not only save the foreign exchange but the cheapest and eco-friendly way to control the common rust of maize.

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