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Synthesis, characterization and fungicidal activity of novel 2-aminopyrimidine Schiff bases

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2-Aminopyrimidines represents vital class of bioactive molecules where its structural changes would lead to its peculiar properties. *N*-heterocyclic compound i.e. 2-aminopyrimidine had wide range of applications in pharmacological, material chemistry and agriculture as antifungal, antimicrobial and antibacterial agents. 2-Aminopyrimidine and its derivatives are good candidates for antimicrobial, antifungal and anticorrosion activity. In the present study, a series of substituted *N*-benzylidine-2-aminopyrimidine compounds have been synthesized by condensation reaction of 2-aminopyrimidine with substituted benzaldehydes (*o*-chloro, *m*-hydroxybenzaldehyde, *p*-hydroxybenzaldehyde, 2,5-dimethoxybenzaldehyde, *p*-dimethylaminobenzaldehye, syringaldehyde, *o*-phthaldehyde, isovanillin benzaldehyde, veratraldehyde and thiophene-2-carboxyaldehyde) using glacial acetic acid or NaOH (40%). The synthesised Schiff bases have been characterized using UV, IR, ^{1}H NMR and ^{13}C spectral studies. 2-Aminopyrimidine Schiff bases (**1-10**) have been examined for fungitoxicity on the growth *of Fusarium verticillioides*, *Rhizoctonia solani and Macrophomina phaseolina* using poisoned food technique.

Keywords: 2-aminopyrimidine, Schiff base, Aromatic aldehydes, Conventional and microwave method, Antifungal activity

The pyrimidine ring is a key structural moiety of vitamins, coenzymes, uric acid and as well as drugs. Nucleic acids contain three types of pyrimidine bases: cytosine (C), thymine (T), and uracil (U). 2-Aminopyrimidines contain two nitrogen atoms in the pyrimidine ring. Several of its derivatives exhibited a wide range of activities and were used in H4 receptor ligands[2]. German chemist Hugo Schiff discovered Schiff bases and was awarded the Nobel Prize in 1864. Schiff bases are generally imines formed by the condensation of carbonyl compounds and amines. Aldehydes form Schiff bases more readily than ketones. With highly efficient conjugation system, aromatic aldehydes are more stable unlike their aliphatic counterparts which are unstable and readily polymerize. Schiff base compounds and their metal complexes were prepared and their behaviour was studied, as a result, it was found out that these compounds are versatile and have numerous structures[4]. A number of methods are used for the synthesis of Schiff bases *i.e.*conventional[10], microwave irradiation[9], sonication method[8], grindstone[5] using natural acid catalyst[7] or glacial acetic acid.

Fungi are large group of eukaryotic living organisms that contain microganisms such as yeast and mould. These creatures are delegated a realm, organisms, which is isolated from plants creatures and microbes. As an important distinction, fungi have cell dividers that contain chitin, unlike plants, which have cellulose in their cell dividers. A commercially available fungicide, Bavistinis contains two nitrogen atoms and is effective against various pathogenic fungi that can be found on wheat, paddy, barley, cotton and sugarcane.

Experimental Details

Relitech melting point apparatus was used to determine the uncorrected melting points of all compounds by placing open capillaries in it. Progress of reaction was monitored by silica gel-G coated TLC plated in dichloromethane ethyl acetate (1:1). Then plate was dried and spots were visualized after developing it in iodine chamber. λ_{max}(nm) was noted on Shimadzu UV 1800 spectrophotometer. Perkin-Elmer FTIR spectro- Bruker Avance Neo 500 MHz NMR spectrophotometer and Bruker Avance Neo 500 MHz NMR spectrophotometer were used to analyze IR, ^{1}H NMR spectra and ^{13}C NMR, respectively. $CDCl_3$/DMSO-d_6, was used as solvents and TMS as internal standard.

Synthesis and characterization of 2-aminopyrimidine Schiff bases

Conventional method (1-10)

2-Aminopyrimidine and substituted aldehydes were reacted to form Schiff base using 2-3 drops of glacial acetic acid as catalyst in methanolic/ethanolic solution in a round bottom flask with constant stirring till the product formation took place. The progress of reaction was checked with the help of TLC. Finally, the crude product was recrystallized from methanol/ethanol. The precipitate of final product was recrystallized from methanol/ethanol to get pure compound.

Microwave method (1-10)

The condensation reaction containing 2-aminopyrimidine and substituted aldehydes were reacted to form Schiff base using 2-3 drops of glacial acetic acid or NaOH as catalyst in methanolic/ ethanolic solution in a beaker and microwave irradiated till the completion of reaction. The obtained product was checked by thin layer chromatography after interval of one minute and final product was recrystallized from methanol/ethanol to get pure compound.

Spectral information of compounds 1-10 are given below and spectra of few selected compounds are shown in Supplementary Information.

***N*-(2'-Chlorobenzylidene)pyrimidin-2-amine, 1:** White solid, m.p.240-242°C, UV (nm) 288, IR (KBr, υ_{max}, cm^{-1}) 797 (C-Cl stretching), 1683 (C=N stretching), 1256 (C-N stretching), 3065 (aromatic C-H stretching); ^{1}H NMR(500 MHz, DMSO, 'δ', ppm) 8.30 (s, 1H,CH=N), 6.63-8.29 (m, 7H, aromatic protons). ^{13}C NMR(500 MHz, DMSO, 'δ', ppm) 163.20(CH=N) 126.85, 127.74, 129.63, 130.65, 132.70, 135.68, 136.11, 157.85 and 160.80. Anal. calcd for $C_{11}H_8ClN_3$: C, 60.70; H,3.70; Cl, 16.29; N,19.31. Found:C, 60.73; H,3.67; Cl, 16.30; N,19.30

3-((Pyrimidin-2'-ylimino)methyl)phenol, 2: Reddish brown solid, m.p.140-141°C, UV (nm) 316, IR (KBr, υ_{max}, cm^{-1}) 3219 (OH stretching), 1685 (C=N stretching), 1232 (C-O stretching), ^{1}H NMR(500 MHz, DMSO, 'δ', ppm) 8.27 (s,1H,CH=N) 6.61-7.30 (m, 7H, aromatic protons) and 10.33 (s,1H,OH). ^{13}C NMR (500 MHz, DMSO, 'δ', ppm) 163.51 (CH=N), 113.26, 114.62, 116.92, 121.08, 129.18, 137.63, 157.95, 158.03 and 161.14.Anal. calcd for$C_{11}H_9N_3O$: C, 66.32; H,4.55; N, 21.09; O, 8.03.Found: C, 66.34; H, 4.53; N, 21.11; O, 8.01.

4-((Pyrimidin-2'-ylimino)methyl)phenol, 3: Reddish brown solid, m.p.110-112°C, UV (nm) 318,IR (KBr, υ_{max}, cm^{-1}) IR spectrum (KBr, υ_{max}, cm^{-1}) 3204 (OH stretching), 1670 (C=N stretching), 1230 (C-O stretching). ^{1}H NMR spectrum (500 MHz, DMSO, 'δ', ppm) 9.80 (s,1H, CH=N) 6.94-8.80 (m, 7H, aromatic protons) 10.68 (s,1H,OH). ^{13}C NMR (500 MHz, DMSO, 'δ', ppm) 166.64 (CH=N) 115.81, 118.27, 126.43, 128.33, 131.87, 157.99 and 161.87.Anal. calcd for $C_{11}H_9N_3O$: C, 66.32; H,4.55; N, 21.09; O, 8.03.Found C, 66.34; H,4.53; N, 21.11; O, 8.01.

N*-(2',5'-Dimethoxybenzylidene)pyrimidin-2-amine, 4:** White solid, m.p.135-136°C, UV (nm) 298, IR (KBr, υ_{max}, cm^{-1}) 2953 (C-H aliphatic stretching), 1675 (C=N stretching), 1272 (C-N stretching), 1247 (C-O-C stretching). ^{1}H NMR spectrum (500 MHz, DMSO, 'δ', ppm) 8.28 (s,1H, CH=N), 6.54-7.27 (m,6H, aromatic protons) 3.67 (s,3H,OCH_3) and 3.17 (s,3H,OCH_3). ^{13}C NMR (500 MHz, DMSO, 'δ', ppm) 163.44 (CH=N), 55.42(2C,OCH_3) 114.31, 118.74, 121.43, 122.94, 124.22, 156.06,157.78, 158.73 and 160.86.Anal. calcd for $C_{13}H_{13}N_3O_2$: C,64.19; H, 5.39; N,17.27; O,13.15.Found: C,64.22; H, 5.36; N,17.29; O,13.13.N*-(4'-(Dimethylamino)benzylidene)pyrimidin-2-amine, 5:** Pale Brown solid, m.p.55-56°C, UV (nm) 343, IR (KBr, υ_{max}, cm^{-1}) 2705 (C-H aliphatic stretching), 1665 (C=N stretching), 1367 (C-N stretching), 1162 (C-H bending). ^{1}H NMR spectrum (500 MHz, DMSO, 'δ', ppm) 9.67 (s,1H, CH=N) 6.52-8.21 (m, 7H, aromatic protons) and 3.03 (6H,OCH_3). ^{13}C NMR spectrum (500 MHz, DMSO, 'δ', ppm) 161.67 (CH=N), 55.53 (2C,2CH_3), 111.94, 123.99, 127.79,128.69,129.33 and 158.00 and 160.94.Anal. calcd for $C_{13}H_{14}N_4$: C, 69.00; H,6.24 ; N, 24.76.Found: C, 69.04; H,6.21; N, 24.75.

2,6-Dimethoxy-4-((pyrimidin-2′-ylimino)methyl)-phenol, 6: Off White, m.p.250-252°C, UV (nm) 338, IR (KBr, ν, cm^{-1}) 3459 (OH stretching), 2918 (C-H aliphatic stretching), 1649 (C=N stretching),1349 (C-N stretching),1235 (C-O-C stretching), 1161 (aliphatic C-H bending), ^{1}H NMR spectrum (500 MHz, DMSO, 'δ', ppm) 3.68(6H,OCH_3), 8.26(s,1H, CH=N), 8.20-8.21(d, 2H,J=4.80). 6.51-6.56 (t,1H, J=4.80), 6.91(2H,arm. protons), 9.28 (1H,OH). ^{13}C NMR spectrum (500 MHz, DMSO, 'δ', ppm) 169.98 (CH=N), 55.25(2C,2OCH_3), 109.98, 113.81, 127.50, 135.60, 157.90, 162.16 and 163.48.Anal. calcd for $C_{13}H_{13}N_3O_3$:C,60.22; H, 5.05; N,16.21; O,18.51.Found: C,60.23; H, 5.04; N,16.23; O,18.49.

2-((Pyrimidin-2′-ylimino)methyl)benzaldehyde, 7: Light orange solid, m.p.150-152°C, UV (nm) 352,IR (KBr, ν, cm^{-1}) 2946 (C-H stretch aldehyde), 1717 (C=O stretching), 1675 (C=N stretching), 1250 (C-N stretching). ^{1}H NMR spectrum (500MHz, DMSO, 'δ', ppm) 8.40 (s, 1H, CH=N), 6.69 to 8.38

(m,6H, aromatic protons), 10.68(1H,CHO). ^{13}C NMR spectrum (500MHz, DMSO, 'δ', ppm) 166.64 (CH=N), 118.27, 126.43, 127.30, 128.33, 131.87, 131.95, 132.05, 157.90 and 161.01 and 190.78 (1C,CHO).Anal. calcd for $C_{12}H_9N_3O$: C,68.24; H,4.29; N,19.89; O,7.57.Found: C,68.28; H,4.25; N,19.90; O,7.56.

5-Methoxy-2-((pyrimidin-2′-ylimino)methyl)-phenol, 8: Brown solid, m.p.85-87°C,UV (nm) 324,IR spectrum (KBr, ν, cm^{-1})3474 (OH stretching), 2952 (aliphatic C-H stretching),1646 (C=N stretching),1342 (C-N stretching), 1244 (C-O-C). ^{1}H NMR spectrum (500 MHz, DMSO,'δ',ppm) 8.21 (s,1H, CH=N), 9.69(s,1H,OH), 6.02-7.98 (m,6H, aromatic protons) and 3.81(s,3H,OCH_3).^{13}C NMR spectrum (500 MHz, DMSO, 'δ', ppm) 163.46 (CH=N),55.34 (s,1C,OCH_3), 109.96, 110.86, 113.55, 121.34, 130.09, 139.57, 151.29, 154.62 and 157.86.Anal. calcd for $C_{12}H_{11}N_3O_2$:C,62.87; H,4.84; N,18.33; O,13.96.Found: C,62.89; H,4.82; N,18.30; O,13.93.

***N*-(3′,4′-Dimethoxybenzylidene)pyrimidin-2-amine, 9:** Cream solid, m.p.200-202°C, UV (nm) 295,IR spectrum (KBr, ν, cm^{-1}) 2975 (C-H aliphatic stretching), 1667 (C=N stretching), 1314 (C-N stretching), 1213 (C-O-C stretching). ^{1}H NMR spectrum (500MHz, DMSO, 'δ', ppm) 8.27(s,1H, CH=N), 3.95, 3.93 (2C,OCH_3), 5.90 -7.46 (m,6H, aromatic protons). ^{13}C NMR spectrum (500MHz, DMSO, 'δ', ppm)163.26 (CH=N), 56.06 (2C, OCH_3), 114.93, 116.37, 117.04, 122.04, 126.73, 149.52, 154.40, 157.92 and 158.10.Anal. calcd for $C_{13}H_{13}N_3O_2$: 64.19; H,5.39; N,17.27; O,13.15.Found: 64.21; H,5.37; N,17.30; O,13.12.

***N*-(Thiophen-2′ylmethylene)pyrimidin-2-amine, 10:** Yellow solid, m.p.147-150°C, UV (nm) 283,IR spectrum (KBr, ν, cm^{-1}) 1604 (C=N stretching), 1362 (C-N stretching) 636 (C-S stretching) ^{1}H NMR spectrum (500 MHz, DMSO, 'δ', ppm) 9.18 (s, 1H, CH=N),/ 5.74-7.44 (m,6H, aromatic protons). ^{13}C NMR spectrum (500 MHz, $CDCl_3$, 'δ', ppm) 118.39, 124.51, 128.12, 128.30, 136.24, 158.08 and 158.63. Anal. calcd for $C_9H_7H_3S$: C,65.77; H,14.72; S,19.51. Found: C, 65.80; H,14.70; S,19.50.

Antifungal assay

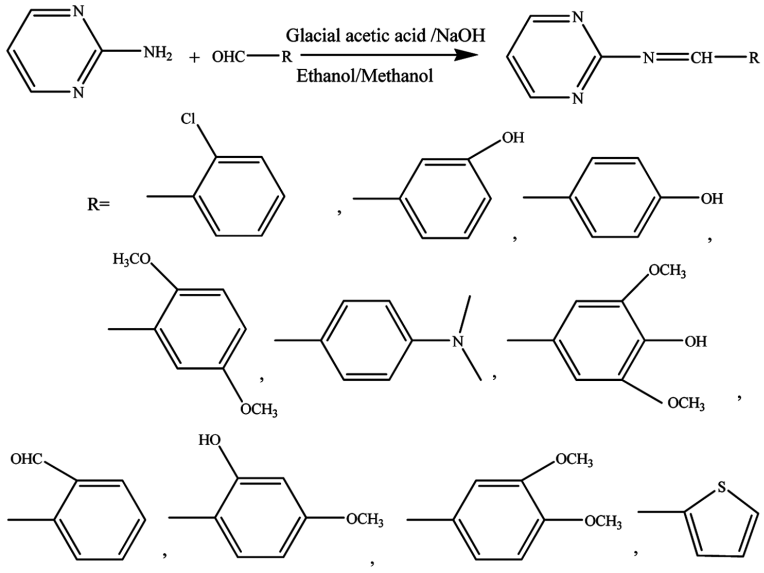
Antifungal potential of the synthesized compounds (**1-10**) was determined using three pathogenic maize fungal strains (*Fusarium verticillioides, Rhizoctonia solani, Macrophomina phaseolina*) which were procured from the Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana. Five different concentrations (1000, 500, 250, 100, and 50 µg/mL) of all the 2-aminopyrimidine derivatives were used and antifungal evaluation was carried out using the Poisoned food technique[6]. Potato Dextrose Agar (PDA) media was made in conical flasks (250 mL) and sterilized in an autoclave at 121°C. To 99 mL of melted PDA, test compound (**1-10)** (1 mL) with different concentrations was added and subsequently poured into the petri plates under an aseptic environment to avoid the contamination of plates. When the media in the Petri plates got solidified, inoculation was done by placing a small disc (0.5 cm diameter) of the test fungi at the center of Petri plates upside down under aseptic conditions and kept under incubation at 25±1°C in BOD. Regular checks were made on the growth of fungi in tested plates and comparison was done with control plates (without test solutions). PDA medium was used to carry out the sub-culturing of three fungal strains for which prepared slants were used. The experiment was carried out using five replications and fungitoxicity of the synthesized derivatives of 2-aminopyrimidines **1-10** was evaluated by calculating percent growth inhibition using the following formula[11];

$$I = \frac{100(C - T)}{C}$$

Where I refer to inhibition percent, C refers to colony diameter in control (cm), T refers to colony diameter in treatment (cm). ED_{50} (effective dose at which 50% inhibition has occurred) values were also calculated using SPSS version 16. ED_{50} values were obtained by plotting a graph between per cent inhibition and concentration, followed by locating concentration corresponding to 50% inhibition.

Results and Discussion

Schiff's bases are an important class of organic compounds possessing biological activities and structural significance. It has been reported that the incorporation of pyrimidine moiety molecule into the biologically active azomethine linkage (-CH=N-) produced compounds with high pharmacological activity. A series of substituted *N*-benzylidine-2-aminopyrimidine Schiff bases were synthesized by condensation reaction of 2-aminopyrimidine with various substituted benzaldehydes (*o*-chloro, *m*-hydroxybenzaldehyde, *p*-hydroxybenzaldehyde, 2,5-dimethoxybenzaldehyde, *p*-dimethylaminobenzaldehye,



Scheme 1 — Synthesis of 2-aminopyrimidne Schiff bases (**1-10**)

Table 1 — Physical parameters of Schiff bases of 2-aminopyrimidine

Compound	Molecular Formula	Molecular Weight	Colour*	Melting Point (°C)	R_f**
1	$C_{11}H_8ClN_3$	217.65	White	240-242	0.46
2	$C_{11}H_9N_3O$	199.21	Reddish brown	140-141	0.47
3	$C_{11}H_9N_3O$	199.21	Reddish Brown	110-112	0.67
4	$C_{13}H_{13}N_3O_2$	243.26	White	135-136	0.90
5	$C_{13}H_{14}N_4$	226.28	Pale Brown	55-56	0.71
6	$C_{13}H_{13}N_3O_3$	259.26	Off white	250-252	0.50
7	$C_{12}H_9N_3O$	211.22	Light orange	150-152	0.75
8	$C_{12}H_{11}N_3O_2$	229.23	Brown	85-87	0.56
9	$C_{13}H_{13}N_3O_2$	243.26	Cream	200-202	0.61
10	$C_9H_7H_3S$	189.24	Yellow	147-150	0.62

*All Schiff bases were obtained in solid form

** The solvent system for TLC was Dichloromethane: Ethyl acetate (1:1)

syringaldehyde, *o*-phthaldehyde, isovanillin benzaldehyde, veratraldehyde and thiophene-2-carboxyaldehyde)(**1-10**) in methanol or ethanol using glacial acetic acid or sodium hydroxide as catalyst using conventional and microwave irradiation method. (Scheme 1). The physical data *i.e.* state, melting point, R_f, colour, yield and time of synthesized compounds was recorded (Table 1). It was observed that time taken in microwave irradiation method was less and yield obtained was more as compared to conventional synthesis (Table 2). The characterization of prepared compounds was done by UV, IR, ^{1}H NMR and ^{13}C NMR spectroscopic techniques. The confirmation for formation of Schiff bases was assured by -CH=N- band by IR in the range of 1604- 1685 cm^{-1} and 8.21-9.67 ppm signal in ^{1}H NMR and signal in ^{13}C NMR spectrum in range 161.67 -166.64 ppm.

Antifungal activity

Antifungal activities for all compounds (**1-10**) were screened against *Fusarium verticillioides*, *Rhizoctonia solani and Macrophomina phaseolina* using carbendazim 50 WP as standard using poisoned food technique. Compound **5** containing *p*-dimethylamino moeity along with pyrimidine showed hundred percent inhibition at all concentrations whereas compound **6** containing syringaldehyic moeity was least effective among all compounds against fungi *Fusarium verticillioides, Rhizoctonia solani and Macrophominaphaseolina*.(Table 3-5). Lowest ED_{50} value was shown by compound **5** of 10.68 µg mL^{-1}. It was also observed that compound **4** and **3** showed comparatively more fungal growth than compound **8** which had ED_{50} 393.83 µg mL^{-1} against *Fusarium verticillioides* (Fig. 1a & Table 3). Similar studies against this fungus were reported that the copper(II)

Table 2 — Comparison of yield and time by conventional and microwave irradiation methods

Compound No.	Yield (%)			Time conventional method (min)	Time taken in MW method (min)	Decrease in time (min)
	Conventional method	MW Method	Increase in yield			
1	33.10	35.18	2.08	300	4	296
2	78.72	82.22	3.5	420	35	385
3	52.50	57.78	5.28	480	27	453
4	78.57	84.60	6.03	420	20	400
5	40.17	43.68	3.51	360	24	336
6	61.00	63.00	2.00	480	8	472
7	47.61	52.08	4.47	600	25	575
8	41.20	43.85	2.65	480	5	475
9	57.32	59.65	2.33	480	12	468
10	65.78	76.38	10.60	720	3	717
Range	33.10-78.72	35.18-84.60	2-10.60	300-720	3-35	296-717
Mean	55.59	59.84	4.24	474	16.3	457.7

Table 3 — *In vitro* effect of different Schiff bases of 2-aminopyrimidine on growth of *Fusarium verticillioides* at different

Compound	Percent Inhibition at different concentrations				
	1000 µg mL^{-1}	500 µg mL^{-1}	250 µg mL^{-1}	100 µg mL^{-1}	50 µg mL^{-1}
1	62.55±0.02 (52.25)	50.59±0.25 (45.31)	44.12±0.37 (41.60)	38.63±0.04 (38.41)	25.69±0.32 (30.43)
2	49.80±0.34 (44.86)	41.96±0.34 (40.34)	33.92±0.36 (35.59)	25.10±0.34 (30.02)	22.16±0.45 (28.03)
3	72.94±0.26 (58.63)	66.27±0.39 (54.48)	46.08±0.46 (42.73)	38.63±0.38 (38.40)	33.53±0.04 (35.35)
4	65.29±0.03 (53.90)	61.18±0.02 (51.45)	50.00±0.42 (44.98)	47.84±0.37 (43.74)	43.92±0.26 (41.48)
5	100±0.00 (89.96)	100±0.00 (89.96)	100±0.00 (89.96)	100±0.00 (89.96)	100±0.00 (89.96)
6	20.00±0.43 (26.54)	12.29±0.32 (20.47)	10.21±0.21 (18.56)	7.29±0.32 (15.54)	4.17±0.02 (11.61)
7	56.86±0.03 (48.93)	46.27±0.02 (42.84)	41.37±0.34 (40.00)	34.90±0.32 (36.18)	27.45±0.16 (31.56)
8	69.80±0.04 (56.69)	64.51±0.48 (53.41)	49.61±0.28 (44.75)	46.67±0.35 (43.06)	16.47±0.16 (23.92)
9	37.84±0.25 (37.94)	27.06± 0.24 (31.30)	15.49±0.29 (23.12)	10.59±0.35 (18.92)	5.49±0.43 (13.48)
10	48.43±0.28 (44.08)	43.14±0.24 (41.03)	35.49±0.36 (36.54)	33.73±0.37 (35.48)	31.18±0.24 (33.92)
Carbendazim50 WP	100±0.00 (89.96)	100±0.00 (89.96)	100±0.00 (89.96)	100±0.00 (89.96)	100±0.00 (89.96)
Particulars				CD (5%)	
Compounds				1.12	
Concentrations				0.75	
Compounds × concentrations				2.51	

complexes with the *para*-substituted Schiff bases were more active than *ortho* and *meta* derivatives against *F. verticilliodes*[3]. Against *R. solani* lowest ED_{50} was shown by most effective compound **5**corresponding to 11.65 µg mL^{-1} followed by compound **9** having 174 µg mL^{-1} at which 50 per cent of inhibition occurred. Carbendazim 50 WP due to its high activity showed very less ED_{50} corresponding to 10 µg mL^{-1} against *R. solani* (Fig. 1b & Table 4). In *M. phaseolina*, compound **5** was most effective followed by compound **8**>**4**>**3**. Each of the synthesized compounds were examined to be effective in comparison with Carbendazim 50 WP, which had ED_{50} of 10µg ml^{-1} for *M. phaseolina* (Fig. 1c & Table 5). Similar studies against *M. phaseolina* were evaluated by showed influence of the central ion of some complexes have an enhanced activity compared to the ligand itself[1].

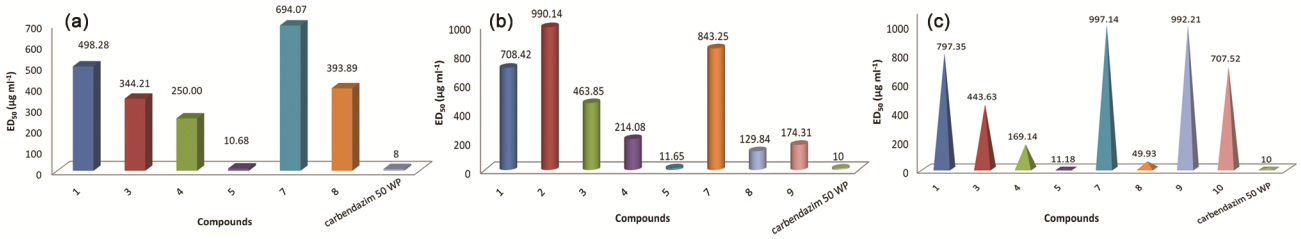


Fig. 1 — ED_{50} values of different Schiff bases of 2-aminopyrimidine against (a) *Fusarium verticillioides,* (b) *Rhizoctonia solani* and (c) *Macrophomina phaseolina*

Table 4 — *In vitro* effect of different Schiff bases of 2-aminopyrimidine on growth of *Rhizoctonia solani*

Compound	Percent Inhibition at different concentrations				
	1000 µg mL^{-1}	500 µg mL^{-1}	250 µg mL^{-1}	100 µg mL^{-1}	50 µg mL^{-1}
1	58.63±0.02 (49.95)	46.67±0.45 (43.06)	36.27±0.26 (37.01)	24.31±0.25 (29.51)	12.35±0.43 (20.35)
2	50.98±0.23 (45.54)	46.27±0.13 (42.84)	36.86±0.04 (37.36)	28.82±0.41 (32.44)	20.20±0.34 (26.69)
3	61.37±0.35 (51.55)	59.61±0.26 (50.52)	48.04±0.34 (43.85)	44.51±0.32 (41.83)	23.33±0.25 (28.85)
4	69.22±0.03 (56.28)	67.65±0.04 (55.31)	57.45±0.26 (49.26)	47.25±0.02 (43.40)	34.51±0.34 (35.93)
5	100.00±0.00 (89.96)	100.00±0.00 (89.96)	100.00±0.00 (89.96)	100.00±0.00 (89.96)	100.00±0.00 (89.96)
6	27.65±0.02 (31.69)	25.29±0.41 (30.15)	22.16±0.34 (28.06)	19.61±0.36 (26.26)	14.12±0.42 (22.03)
7	50.20±0.35 (45.09)	44.71±0.39 (41.94)	37.65±0.42 (37.82)	33.53±0.38 (35.35)	24.12±0.36 (29.38)
8	70.00±0.29 (56.77)	71.76±0.43 (57.88)	68.82±0.48 (56.04)	45.69±0.27 (42.50)	33.53±0.26 (35.36)
9	70.78±0.39 (57.26)	69.61±0.04 (56.52)	60.98±0.25 (51.32)	46.08±0.03 (42.73)	35.88±0.16 (36.77)
10	49.80±0.05 (44.86)	46.27±0.43 (42.84)	40.98±0.48 (39.77)	36.27±0.26 (36.98)	38.04±0.23 (38.05)
Carbendazim50 WP	100±0.00 (89.96)	100±0.00 (89.96)	100±0.00 (89.96)	100±0.00 (89.96)	100±0.00 (89.96)
Particulars				CD (5%)	
Compounds				1.07	
Concentrations				0.72	
Compounds× concentrations				2.39	

Table 5 — *In vitro* effect of different Schiff bases of 2-aminopyrimidine on growth of *Macrophomina phaseolina*

Compound	Percent Inhibition at different concentrations				
	1000 µg mL^{-1}	500 µg mL^{-1}	250 µg mL^{-1}	100 µg mL^{-1}	50 µg mL^{-1}
1	52.7±0.04 (46.55)	46.86±0.03 (43.18)	35.88±0.02 (36.76)	23.92±0.45 (29.25)	19.80±0.36 (26.37)
2	43.92±0.03 (41.48)	40.98±0.01 (39.78)	36.86±0.30 (37.36)	22.35±0.08 (28.18)	18.63±0.31 (25.52)
3	63.92±0.36 (53.06)	61.37±0.03 (51.55)	45.69±0.04 (42.50)	38.04±0.52 (38.05)	30.20±0.02 (33.29)
4	64.51±0.03 (53.43)	59.02±0.34 (50.17)	57.06±0.41 (49.03)	43.73±0.48 (41.37)	33.33±0.23 (35.24)
5	100.00±0.00 (89.96)	100.00±0.00 (89.96)	100.00±0.00 (89.96)	100.00±0.00 (89.96)	100.00±0.00 (89.96)

(*Contd.*)

Table 5 — *In vitro* effect of different Schiff bases of 2-aminopyrimidine on growth of *Macrophomina phaseolina*

Compound	Percent Inhibition at different concentrations				
	1000 µgmL^{-1}	500 µg mL^{-1}	250 µg mL^{-1}	100 µg mL^{-1}	50 µg mL^{-1}
6	35.88±0.25 (36.78)	33.14±0.04 (35.12)	20.00±0.21 (26.50)	18.04±0.34 (25.09)	12.16±0.43 (20.32)
7	50.39±0.28 (45.20)	48.82±0.34 (44.30)	43.53±0.04 (41.26)	33.53±0.22 (35.35)	25.69±0.48 (30.37)
8	69.41±0.47 (56.40)	66.27±0.28 (54.48)	62.55±0.41 (52.25)	60.00±0.31 (50.74)	50.78±0.41 (45.43)
9	50.39±0.25 (45.20)	43.73±0.27 (41.37)	34.51±0.45 (35.95)	23.92±0.41 (29.25)	22.94±0.28 (28.59)
10	51.96±0.42 (46.10)	49.22±0.25 (44.53)	46.86±0.28 (43.18)	44.71±0.43 (41.93)	40.00±0.41 (39.21)
Carbendazim 50 WP	100±0.00 (89.96)	100±0.00 (89.96)	100±0.00 (89.96)	100±0.00 (89.96)	100±0.00 (89.96)
	Particulars			CD (5%)	
	Compounds			1.05	
	Concentrations			0.71	
	Compounds × concentrations			2.35	

Conclusion

2-Aminopyrimidine derived Schiff bases (**1-10**) were synthesized by reacting different aromatic aldehydes with 2-aminopyrimidine in the presence of catalytic amount of glacial acetic acid or NaOH (40%) in methanol/ethanol. These were synthesized by both conventional as well as microwave irradiation method. Microwave assisted method for synthesis of Schiff bases gave more yield as compared to conventional method. Also, time taken in microwave irradiation synthesis was less in comparison with conventional synthesis. The confirmation for formation of Schiff bases was assured by -CH=N- peak in IR 1583- 1685 cm^{-1} range and 8.21-9.80 ppm signal in ^{1}H NMR and signal in ^{13}C NMR spectrum in range of 161.67-166.64 ppm. These were evaluated for their fungicidal activity against *F. verticillioides*, *R. solani and M. phaseolina* using poisoned food technique. Compound **5** containing *p*-dimethylamino group registered maximum activity and was found to be most effective whereas compound **6** containing syringaldehyic group was least effective among all compounds against all the three fungi *F. verticillioides*, *R. solani and M. phaseolina*. Standard Carbendazim 50 WP exhibited lowest ED_{50} value than all the prepared compounds. It was observed that standard Carbendazim 50 WP was highly effective than all the prepared compounds. So overall, compound **5** registered broad spectrum fungitoxicity but less than the fungicide Carbendazim 50 WP.

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Supplementary Information

Supplementary information is available in the website http://nopr.niscpr.res.in/handle/123456789/58776.

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