Research Article

Effect of UVC Rays on Aqua Suspension Formulations of *Nomuraea Rileyi* (Farlow) Samson

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Abstract

The effect of UVC rays on the viability of entomopathogenic fungus**,** *Nomuraea rileyi* (Farlow) Samson, in eleven various formulations comprising with *N.r*+honey (*N.r*+HO 1.0%), *N.r*+sunflower oil (*N.r*+SFO 1.0%) and *N.r*+ghee (*N.r*+GH 0.5%) alone and formulations with combination with *N.r*+tween-80+ghee (*N.r*+TW0.5%+GH0.5%), *N.r*+ glycerol +sunflower oil (*N.r*+GLY2.0%+SFO1.0%), *N.r*+glycerol+ghee (*N.r*+GLY 2.0%+GH0.5%), *N.r*+sunflower oil+ghee (*N.r*+SFO1.0% +GH0.5%), *N.r*+tween-80+ glycerol+sunflower oil+ carboxymethyl cellulose (*N.r*+TW0.5%+GLY2.0% +SFO1.0%+CMC0.5%), *N.r*+tween-80+glycerol+honey (*N.r*+TW0.5%+GLY2.0%+HO1.0%), *N.r*+tween-80+ glycerol+carboxymethyl cellulose (*N.r*+TW0.5%+ GLY2.0%+CMC0.5%) and control without adjuvants (*N.rileyi* alone) of *N.rileyi* when exposed for 10 to 50 minutes, 2,3 and 5 hours were studied under laboratory conditions. The UVC rays proved detrimental to the fungus and the effect increased with increase in exposure period. After 5 hours exposure to UVC rays, *N.r.*+SFO 1.0% produced highest (4.95g) biomass when it was in rest of the treatments (3.50 to 4.95g) against 2.23g in control (*N.r.* alone). The next promising treatments were *N.r*+TW0.5%+ GLY2.0%+HO1.0%) (4.40g), *N.r*+TW0.5%+ GLY2.0%+CMC0.5% (4.08g) and *N.r*+HO 1.0% (3.92g). The control *N.r.*alone without UVC exposure produced 6.90g of fungal biomass.

Keywords: *Nomuraea rileyi*, media, yeast extract, Ultraviolet, formulations, biomass

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Introduction

Nomuraea rileyi (Farlow) Samson Moniliales, Moniliaceae is a fungus of cosmopolitan nature. *N.rileyi* infects mainly Lepidoptera, particularly economical important and polyphagous noctuid insect pests. *N.rileyi* is an entomopathogen causing natural mortality in as many as 51 Lepidopteran insects throughout the world [1]. *N.rileyi* frequently cause epizootics in nature, is one promising because of its wide spread occurrence and relative abundance due to its wide host range which included many catterpiller pests. Progress of research on *N.rileyi* in India is slow though the results of the few studies have revealed that *N.rileyi* as a potential mycoinsecticide [2]. Efficiency of entomopathogens in the field depends upon virulence towards target pest, coverage and persistence on target site. However, major constraints for successful use of such bio-agents are their difficulties in use of pure cultures, survival on crop after application, loosing virulence by ultra violet (UV) rays, short shelf life, and dependability on the prevailing environmental conditions are the problems reported by [3].

The efficacy of pathogens in the field depends on environmental conditions. The extreme temperatures and light including ultraviolet (UV) may influence the distribution of micro-organisms and their persistence in nature [4]. A rapid decrease of viable spores exposed to direct sunlight and they suggested that the spore mortality was caused by UV radiation [5]. The solar radiation (UV-B radiation) are the major challenges to mycoinsecticide viability. Several reports are available on effect of temperature on growth and activity of fungi [6, 7]. In the presence study laboratory study were undertaken to determine the UV rays protecting ability of various adjuvants used for entomopathogenic fungal formulation. Therefore, the study was carried out to determine the impact of UV rays on the surface growth and biomass production of fungus by various formulations after exposure to UVC rays.

Material and Methods

The pure fungus culture of *N.rileyi* was made, available from isolates in Biocontrol Lab of Entomological centre, College of Agriculture, Pune.

Laboratory study was carried out in the Biocontrol Research Laboratory of the Department of Entomology of the University at MPKV, Rahuri, Maharashtra during 2009 to 2012. The Sabouraud's dextros broth with yeast extract medium was used for multiplication and growth of the fungus. The highly promising 11 formulations comprising, *N.r*+honey (*N.r*+HO 1.0%), *N.r*+sunflower oil (*N.r*+SFO 1.0%) and *N.r*+ghee (*N.r*+GH 0.5%) alone and formulations with combination with *N.r*+tween-80+ghee (*N.r*+TW0.5%+GH0.5%), *N.r*+ glycerol+sunflower oil (*N.r*+ GLY2.0%+SFO1.0%), *N.r*+glycerol+ghee (*N.r*+GLY2.0%+GH0.5%), *N.r*+sunflower oil+ghee (*N.r*+ SFO1.0%+GH0.5%), *N.r*+tween-80+ glycerol+sunflower oil+carboxymethyl cellulose (*N.r*+TW0.5%+ GLY2.0%+SFO1.0%+CMC0.5%), *N.r*+tween-80+glycerol+honey (*N.r*+TW0.5%+GLY2.0%+HO1.0%), *N.r*+tween-80+glycerol+carboxymethyl cellulose (*N.r*+TW0.5%+GLY2.0%+CMC0.5%) and control without adjuvants (*N.rileyi* alone) of *N.rileyi* were evaluated in C.R.D. with 3 replications for their UVC rays protecting ability along with *N.rileyi* 30% AS. One formulation without adjuvant and without UVC rays exposure was also kept for determine the effect of UVC rays. Various concentrations of adjuvants were added to optimum concentration of *N.rileyi* aqua suspension 30% v/v to prepare various formulations. Each formulation was kept in 100ml saline glass bottle. Each formulation were kept in 50 ml glass beaker and such formulations were exposed to UVC rays through UV light source of Phillips TUV lamp for 10, 20, 30, 40, 50 minutes, 2, 3 and 5 hours. The distance between exposed suspension and UV light source was 0.30 m.

One ml of such exposed formulation was added to 40ml Sabouraud's dextrose (SD) broth + Yeast extract medium and observed for growth and development up to 10 days. The observations on per cent surface coverage by fungus on 3rd, 7th and 10th days and fungal biomass on 10th day after inoculation were noted. The experimental data were subjected to statistical analysis.

Result and Discussion

Effect of UVC rays on growth and development of inoculum of formulations

Effect on growth (surface coverage) after exposure to UVC rays

The data on the promising formulations of *N.rileyi* exposed to UVC rays for 10 to 50 minutes and 2, 3 and 5 hours are presented in **Tables 1** to **3** and observations on per cent surface coverage by the fungal growth on the medium although noted at 3,7 and 10 days after exposure.

Table 1 Influence of AS formulations of *N.rileyi* exposed to UVC rays for 10 and 20 minutes on growth of inoculum

Tr. No.	Treatment	Conc. of adj. (%)	Surface coverage (%)					
			10 min. UVC exposure			20 min. UVC exposure		
			3 DAI	7 DAI	10 DAI	3 DAI	7 DAI	10 DAI
T1	*N.r.*+ HO	1.0	83.33 (65.88)*	100.00 (90.00)	100.00 (90.00)	73.33 (58.89)	100.00 (90.00)	100.00 (90.00)
T2	*N.r.*+ SFO	1.0	78.33 (62.24)	100.00 (90.00)	100.00 (90.00)	76.67 (61.14)	100.00 (90.00)	100.00 (90.00)
T3	*N.r.*+ GH	0.5	70.00 (56.79)	100.00 (90.00)	100.00 (90.00)	66.67 (54.76)	100.00 (90.00)	100.00 (90.00)
T4	*N.r.*+TW +GH	0.5+0.5	28.33 (32.14)	71.67 (57.76)	100.00 (90.00)	26.67 (31.11)	68.33 (55.73)	100.00 (90.00)
T5	*N.r.*+ GLY+SFO	2.0+1.0	26.67 (31.11)	93.33 (75.00)	100.00 (90.00)	26.67 (31.11)	91.67 (73.26)	100.00 (90.00)
T6	*N.r.*+ GLY+GH	2.0+0.5	66.67 (54.51)	91.67 (73.26)	100.00 (90.00)	63.33 (52.71)	90.00 (84.26)	100.00 (90.00)
T7	*N.r.*+ SFO+GH	1.0+0.5	28.33 (32.14)	71.67 (57.76)	100.00 (90.00)	26.67 (31.11)	71.67 (57.86)	100.00 (90.00)
T8	*N.r.*+ TW+GLY +SFO+CMC	0.5+2 +1+0.5	25.00 (30.00)	100.00 (90.00)	100.00 (90.00)	21.67 (27.76)	100.00 (90.00)	100.00 (90.00)

T9	*N.r.*+TW+GLY+HO	0.5+2+1	28.33 (32.14)	100.00 (90.00)	100.00 (90.00)	25.00 (30.00)	100.00 (90.00)	100.00 (90.00)
T10	*N.r.*+TW+GLY+CMC	0.5+2+0.5	28.33 (32.14)	100.00 (90.00)	100.00 (90.00)	25.00 (30.00)	100.00 (90.00)	100.00 (90.00)
T11	Control (*N.r.*alone)	-	16.67 (24.12)	61.67 (51.77)	100.00 (90.00)	13.33 (21.39)	58.33 (49.79)	100.00 (90.00)
T12	Control (W.UVC)	-	28.33 (32.14)	65.00 (53.73)	100.00 (90.00)	30.00 (33.21)	61.67 (51.77)	100.00 (90.00)
	S.E+		**1.67**	**1.57**	**-**	**1.37**	**1.71**	**-**
	C.D (P=0.05)		**4.87**	**4.59**	**-**	**4.00**	**5.00**	**-**

*Figures in parentheses are arc sin values, W.UVC= without UVC, *N.r. = Nomuraea rileyi*, DAI = Days after inoculation, TW = Tween-80, HO = Honey, SFO = Sunflower oil, GH = Ghee, GLY = Glycerol, CMC = Carboxymethyl Cellulose

Table 2 Influence of AS formulations of N.rileyi exposed to UVC rays for 30, 40 and 50 minutes on growth of inoculum

T. No	**Treatment**	**Conc Of adj. (%)**	**Surface area covered (%)**								
			30 min. UVC exposure			**40 min. UVC exposure**			**50 min. UVC exposure**		
			3 DAI	**7 DAI**	**10 DAI**	**3 DAI**	**7 DAI**	**10 DAI**	**3 DAI**	**7 DAI**	**10 DAI**
T1	N.r.+HO	1.0	71.67 (57.86)	98.33 (82.51)	100.0 (90.0)	66.67 (54.76)	100.00 (90.00)	100.0 (90.0)	60.00 (50.77)	98.33 (82.51)	100.0 (90.00)
T2	N.r.+SFO	1.0	76.67 (61.14)	100.00 (90.00)	100.0 (90.0)	75.0 (60.0)	100.00 (90.00)	100.0 (90.0)	68.33 (55.73)	100.00 (90.00)	100.0 (90.00)
T3	*N.r.*+ GH	0.5	65.00 (53.73)	100.00 (90.00)	100.0 (90.0)	61.67 (51.77)	100.0 (90.0)	100.0 (90.0)	55.00 (47.87)	100.00 (90.00)	100.0 (90.00)
T4	*N.r.*+TW +GH	0.5+0.5	25.00 (30.00)	63.33 (52.71)	100.0 (90.0)	23.33 (28.86)	58.33 (49.79)	96.67 (79.53)	18.33 (25.33)	51.67 (45.97)	93.33 (75.00)
T5	*N.r.*+GLY+SFO	2.0+1.0	25.00 (30.00)	86.67 (68.61)	100.0 (90.0)	23.33 (28.86)	80.0 (63.44)	100.0 (90.0)	20.00 (26.56)	76.67 (61.14)	98.33 (82.51)
T6	*N.r.*+GLY+GH	2.0+0.5	51.67 (45.97)	86.67 (68.61)	100.0 (90.0)	48.33 (44.03)	85.0 (67.21)	98.33 (82.51)	43.33 (41.15)	81.67 (64.67)	98.33 (82.51)
T7	*N.r.*+ SFO +GH	1.0+0.5	25.00 (30.00)	66.67 (54.76)	100.0 (90.0)	23.33 (28.86)	61.67 (51.77	93.33 (75.0)	20.00 (26.56)	58.33 (49.79)	91.67 (73.26)
T8	*N.r.*+ TW+GLY +SFO+CMC	0.5+2+1+0.5	20.00 (26.56)	93.33 (75.0)	100.0 (90.0)	20.0 (26.56)	91.67 (73.26)	96.67 (79.53)	20.00 (26.56)	90.00 (71.56)	93.33 (75.00)
T9	*N.r.*+ TW +GLY+HO	0.5+2+1	26.67 (31.11)	96.67 (79.53)	100.0 (90.0)	25.0 (30.0)	93.33 (75.00)	100.0 (90.0)	23.33 (28.86)	91.67 (73.26)	100.0 (90.00)
T10	*N.r.*+ TW +GLY+CMC	0.5+2+0.5	25.00 (30.00)	95.00 (77.08)	100.0 (90.0)	23.33 (28.86)	93.33 (75.00)	96.67 (79.53)	20.00 (26.56)	86.67 (68.61)	95.00 (77.08)
T11	Control (*N.r* alone)	-	13.33 (21.39)	51.67 (45.97)	100.0 (90.0)	13.33 (21.39)	50.0 (45.0)	91.67 (73.26)	13.33 (21.39)	43.33 (41.15)	90.00 (71.56)
T12	Control (W.UVC)	-	30.00 (33.21)	65.00 (53.73)	100.0 (90.0)	30.00 (3321)	65.00 (53.73)	100.0 (90.0)	28.33 (32.14)	61.67 (51.77)	100.0 (90.0)
	S.E+		**1.19**	**1.88**	**-**	**1.17**	**1.04**	**1.86**	**1.56**	**1.37**	**1.57**
	C.D (P=0.05)		**3.47**	**5.49**	**-**	**3.40**	**3.03**	**5.44**	**4.55**	**4.01**	**4.60**

UVC exposure- 10 to 50 minutes

After 10 minutes exposure to UVC rays adjuvants in T1- *N.r.*+HO recorded highest (83.33%) growth of fungus at 3 DAI. However, it was at par with T2- *N.r.*+SFO (78.33%), followed by T3- *N.r.*+GH (70.00%) and T6- *N.r.*+GLY+GH (66.67%). Least (16.67%) surface coverage was registered in T11-control.. Similar trend of growth and development was observed at 7 DAI. T1- *N.r.*+HO, T2- *N.r.*+SFO, T3- *N.r.*+GH, T8- *N.r.*+TW+GLY+SFO+CMC, T9-*N.r.*+TW+GLY+HO and T10- *N.r.*+TW+GLY+CMC registered cent per cent growth and development of fungus in culture medium.The per cent surface coverage after 20, 30, 40 and 50 minutes to UVC exposure, the treatments at 3 DAI was in the range of 13.33 to 76.67, 13.33 to 76.67, 13.33 to 75.00 and

13.33 to 68.33 against corresponding figures of 58.33 to 100.0, 51.67 to 100.0, 50.00 to 100.0 and 43.33 to 100.0 at 7 DAI, resepectively. At 10 DAI, all the treatments registered cent per cent surface coverage after 10, 20 and 30 minutes.

Table 3 Influence of AS formulations of *N.rileyi* exposed to UVC rays for 2, 3 and 5 hours on growth of inoculum

T. No	Treatment	Conc Of adj. (%)	Surface area covered (%)								
			30 min. UVC exposure			40 min. UVC exposure			50 min. UVC exposure		
			3 DAI	7 DAI	10 DAI	3 DAI	7 DAI	10 DAI	3 DAI	7 DAI	10 DAI
T1	*N.r.*+HO	1.0	0.00 (0.00)*	98.33 (82.51)	100.00 (90.0)	0.00 (0.00)	95.00 (77.08)	100.00 (90.00)	0.00 (0.00)	90.00 (71.56)	98.33 (82.51)
T2	*N.r.*+SFO	1.0	0.00 (0.00)	100.00 (90.00)	100.00 (90.0)	0.00 (0.00)	98.33 (82.51)	100.00 (90.00)	0.00 (0.00)	96.67 (79.53)	100.00 (90.00)
T3	*N.r.*+GH	0.5	0.00 (0.00)	96.67 (79.53)	100.00 (90.0)	0.00 (0.00)	93.33 (75.00)	100.00 (90.00)	0.00 (0.00)	86.67 (68.61)	98.33 (82.51)
T4	*N.r.*+TW + GH	0.5 +0.5	0.00 (0.00)	41.67 (40.22)	81.67 (64.67)	0.00 (0.00)	38.33 (38.23)	76.67 (61.14)	0.00 (0.00)	28.33 (32.14)	68.33 (55.73)
T5	*N.r.*+ GLY+ SFO	2.0 +1.0	0.00 (0.00)	66.67 (54.76)	90.00 (71.56)	0.00 (0.00)	66.67 (54.76)	86.67 (68.61)	0.00 (0.00)	58.33 (49.79)	81.67 (64.67)
T6	*N.r.*+ GLY+ GH	2.0 +0.5	0.00 (0.00)	65.00 (53.73)	93.33 (75.00)	0.00 (0.00)	53.33 (46.89)	88.33 (70.00)	0.00 (0.00)	48.33 (44.03)	78.33 (62.24)
T7	*N.r.*+ SFO +GH	1.0 +0.5	0.00 (0.00)	51.67 (45.97)	83.33 (65.88)	0.00 (0.00)	46.67 (43.11)	80.00 (63.44)	0.00 (0.00)	36.67 (37.29)	70.00 (56.79)
T8	*N.r.*+TW+ GLY+SFO+ CMC	0.5+2 +1+ 0.5	0.00 (0.00)	83.33 (65.88)	88.33 (70.00)	0.00 (0.00)	78.33 (62.24)	85.00 (67.21)	0.00 (0.00)	68.33 (55.73)	78.33 (62.24)
T9	*N.r.*+TW+ GLY+HO	0.5 +2+1	0.00 (0.00)	81.67 (64.67)	96.67 (79.53)	0.00 (0.00)	66.67 (54.76)	86.67 (68.61)	0.00 (0.00)	63.33 (52.71)	81.67 (64.67)
T10	*N.r.*+ TW+ GLY+CMC	0.5+2 +0.5	0.00 (0.00)	76.67 (61.14)	85.00 (67.21)	0.00 (0.00)	63.33 (52.71)	81.67 (64.67)	0.00 (0.00)	56.67 (48.85)	70.00 (56.79)
T11	Control (*N.r.*alone)	-	0.00 (0.00)	33.33 (35.24)	75.00 (60.0)	0.00 (0.00)	28.33 (32.14)	73.33 (58.89)	0.00 (0.00)	23.33 (28.86)	65.00 (53.73)
T12	Control (W.UVC)	-	30.00 (33.21)	65.00 (53.73)	100.0 (90.0)	30.00 (33.21)	65.00 (53.73)	100.0 (90.0)	30.00 (33.21	61.67 (51.77)	100.0 (90.0)
	S.E+		**-**	**1.55**	**1.64**	**-**	**1.36**	**1.47**	**-**	**1.42**	**1.57**
	C.D (P=0.05)		**-**	**4.53**	**4.79**	**-**	**3.98**	**4.30**	**-**	**4.15**	**4.58**

UVC exposure- 2, 3 and 5 hours

Data presented in Table 3 revealed that all the aqua suspension formulations exposed to UVC rays prevented the growth of fungus at 3 DAI. The surface coverage by the fungus on medium was in the range 33.33 to 100.0, 28.33 to 98.33 and 23.33 to 96.67 at 7 DAI against 75.00 to 100.0, 73.33 to 100.0 and 65.00 to 100.0 at 10 DAI at 2, 3 and 5 hours exposure, respectively.

Effect on develpoment (biomass production)

The biomass produced by the mycoagent in formulation treatments with various adjuvants in SDY medium after UVC irradiation for 10 to 50 minutes and 2, 3 and 5 hours are presented in **Table 4** and depicted in **Figure 1**. The differences in biomass production in the treatments were significant and trend of performance of formulations were more or less similar to that observed for medium surface coverage at 3 and 7 days.

After 10 minutes UVC exposure, *N.rileyi* with adjuvant in T2- *N.r.*+SFO produced significantly highest (5.60g) biomass. The next best and at par formulations in their descending order for potential to produce the biomass were T9- *N.r.*+TW+GLY+HO (5.07g), T1- *N.r.*+HO (4.93g), T3- *N.r.*+GH (4.87g) and T10- *N.r.*+TW+GLY+CMC (4.87g).

Table 4 Effect of UVC treatment on biomass production by advanced test *N.rileyi* AS formulations

Tr. No.	Treatments	Conc. (%) Of adj.	Biomass (g) at 10 DAI after indicated exposure							
			10	20	30	40	50	2 hrs	3 hrs	5 hrs
T1	*N.r.*+ HO	1.0	4.93	4.83	4.67	4.55	4.45	4.22	4.05	3.92
T2	*N.r.*+ SFO	1.0	5.60	5.53	5.37	5.28	5.22	5.13	5.02	4.95
T3	*N.r.*+ GH	0.5	4.87	4.78	4.60	4.45	4.35	4.13	3.72	3.90
T4	*N.r.*+TW +GH	0.5+0.5	4.60	4.55	4.42	4.25	4.15	3.98	3.82	3.65
T5	*N.r.*+ GLY+SFO	2.0+1.0	4.53	4.50	4.38	4.25	4.15	3.97	3.80	3.62
T6	*N.r.*+ GLY+GH	2.0+0.5	4.57	4.52	4.35	4.25	4.15	3.93	3.73	3.58
T7	*N.r.*+ SFO+GH	1.0+0.5	4.47	4.43	4.27	4.10	4.00	3.80	3.60	3.50
T8	*N.r.*+ TW+GLY +SFO+CMC	0.5+2+1+0.5	4.67	4.60	4.43	4.23	4.13	3.90	3.70	3.60
T9	*N.r.*+TW+GLY+HO	0.5+2+1	5.07	5.03	4.98	4.85	4.80	4.65	4.50	4.40
T10	*N.r.*+TW+GLY+CMC	0.5+2+0.5	4.87	4.83	4.75	4.63	4.57	4.37	4.18	4.08
T11	Control(*N.r.*alone)	-	3.43	3.35	3.20	3.03	2.95	2.58	2.45	2.23
T12	Control(*N.r.*alnoe) (W.UVC)	-	6.70	7.00	6.80	6.90	6.90	7.00	6.90	6.90
	S.E ±		**0.06**	**0.07**	**0.06**	**0.05**	**0.05**	**0.05**	**0.05**	**0.04**
	C.D(P=0.05)		**0.17**	**0.19**	**0.17**	**0.15**	**0.16**	**0.15**	**0.14**	**0.13**

W.UVC = without UVC, DAI = Days after inoculation, *N.r.* = *Nomuraea rileyi*, SFO = Sunflower oil, GH = Ghee, HO = Honey, GLY = Glycerol, TW = Tween-80, CMC = Carboxymethyl Cellulose

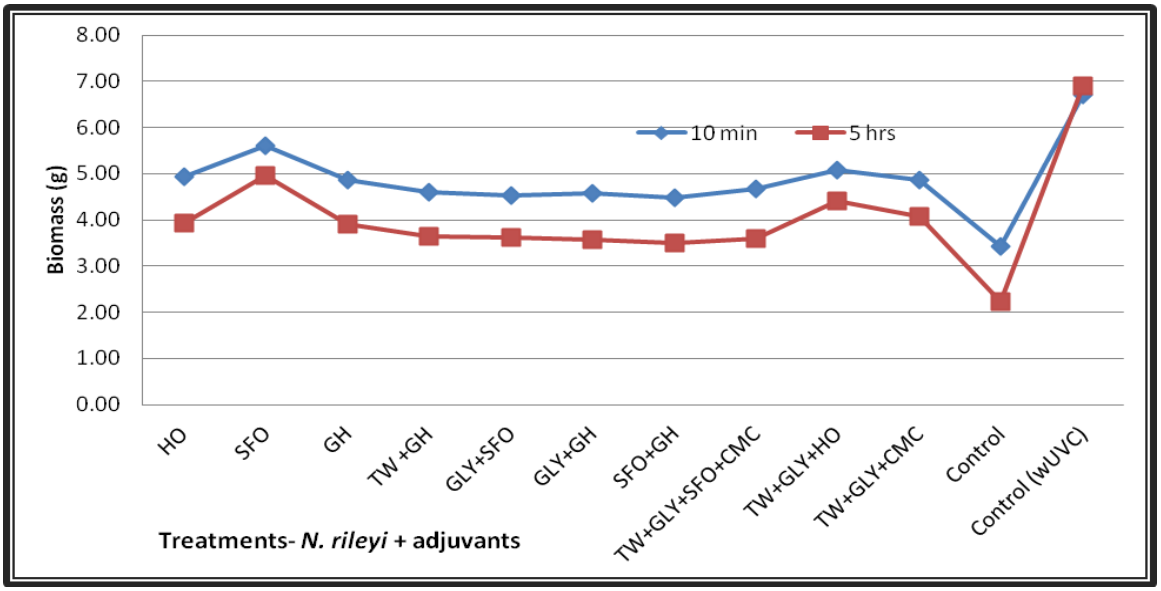

Figure 1 Effect of 10 minutes and 5 hrs UVC exposure on biomass production by *N. releyi* with adjuvants

After the 20 minutes exposure, significantly maximum biomass (5.53g) in T2- *N.r.*+SFO was registered. The next promising formulations were T9- *N.r.*+TW+GLY+HO (5.03g), T10- *N.r.*+TW+GLY+CMC (4.83g), T1- *N.r.*+HO (4.83g) and T3- *N.r.*+GH (4.55g) which were on par with each other. After 30 minutes exposure, T2- *N.r.*+SFO produced 5.37g biomass which was significantly highest than other formulations (4.27 to 4.98g) and control (3.20g). The next promising formulation for production of biomass was T9- *N.r.*+TW+GLY+HO (4.98g). The trend of results of 40 and 50 minutes, 2 and 3 hours exposure were more or less similar to that of 30 minutes UVC rays exposure. There were significant differences among treatments for fungal biomass production at 5 hours UVC exposu**re**. The

treatment with adjuvant *N.r.*+SFO 1.0% produced highest (4.95g) biomass when it was in rest of the treatments (3.50 to 4.95g) against 2.30g in control (*N.r.* alone). The next promising treatments were *N.r.*+HO 1.0% (4.92g), *N.r.*+GNO 1.0% (4.87g) and *N.r.*+GNO 2.0% (4.77g). The control *N.r.*alone without UVC exposure produced 7.30g of fungal biomass.

It was indicated that surface coverage in medium and biomass produced *N.rileyi* with or without adjuvants in culture medium after exposure to UVC rays for 10 to 50 minutes, 2, 3 and 5 hours decreased with increased exposure period. The adjuvants reacted variably for their UVC ray protectant capacity for *N.rileyi.* Among the various formulations tested T2- *N.r.*+SFO, T9- *N.r.*+TW+GLY+HO & T10-*N.r.*+TW+GLY+CMC act as promising appreciable UVC protectant.

According to [8], the chemical sunscreen incorporated in oil formulations of the *Metarhizium spp. g*ave protection after solar radiation of 2 h but increased exposure upto 5h failed to offer protection. The conidial viability of *Metarhizium spp.* decreased with increased UV exposure [9]. Similarly [10] reported that germination of *Metarhizium anisopliae* decreased with increasing exposure time to solar radiation. Peanut oil enhanced the conidial tolerance against UV light for upto 6 h of exposure compared to unformulated and tween-80. Reduction in relative per cent culturability of *M.anisopliae* with increased UV exposure from 1 to 8 h reported by [11]. Carbon source plus 1% NaCl or KCl with high alkalinity had the highest UVB tolerance [12]. Conidia of *M.anisopliae* with oil emulsion had higher survival after 3h of UV exposure [13]. These findings are in line with the present investigation.

Conclusion

It is concluded from the results that UV rays were detrimental to the growth and development of *N.rileyi* and the effect increased with increasing exposure period. However, the formulations *N.rileyi* + Sunflower oil and *N.rileyi* +Tween 80+Glycerol+Honey proved to be effective UV protectants for this entomolpathogen.

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