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Management of Alternaria leaf spot of Ashwagandha (*Withania somnifera* L.) by organic products

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Abstract
Ashwagandha (*Withania somnifera*) plants are major source of alkaloids including tropine, pseudotropine and somniferine. Which are used in pharmaceutical industries. Leaf spot disease caused by Alternaria alternate is found severe form in Uttar Pradesh. Therefore, study has been done for management of leaf spot disease with fungicides and organics and their effects on biomass production of Ashwagandha. The minimum leaf spot intensity was recorded in Ridomil MZ (4.80%) followed by Kovach (4.93%), Antracoal (5.30%), Streptocycline sulphate (6.93%), Bayleton (7.47%) and Metalaxyl (8.07%) at 10 days after 1st spray. 10 days after second spray, the lowest disease intensity was recorded in Kovach (8.40%) followed by Redomil (8.53%, Antracoal (10.80%) and Streptocycline sulphate (11.47%). The number of berry per plants was recorded highest in Kovach (81.67) followed by *Trichoderma* (80.10), cow urine (76.33) and Redomil (74.33). Average number of berry per plants was found 55.07 in control. The maximum seed yield per plot was observed in Ridomil (0.670 kg) followed by Kovach (0.672 kg), Trichoderma harzianum (0.671 kg) and panchgavya (0.671 kg). Percent disease control was recorded maximum in Ridomil MZ (65.78) followed by Kavach (64.12) and Antracol (60.15). In case of organics, highest control was found in *P. fluorescens* (34.74%) followed by *Trichoderma harzianum (31.75%)* and Panchgavya (31.03%).

Keywords: Ashwagandha, *Alternaria*, leaf spot, disease intensity, growth and yield

Introduction
Ashwagandha (*Withania somnifera* L.) is an important medicinal plant and major source of alkaloid and steroidal lactones (with anolides). Which are regularly used in pharmaceutical industries? It grows well in dry and sub-tropical regions of India *viz;* Rajasthan, Punjab, Haryana, Uttar Pradesh, Gujarat, Madhya Pradesh and Maharashtra. The two species of Ashwagandha are grown in India, such as *Withania coagulans* and *Withania somnifera*. The estimated production of its roots in India is more than 1500 tonnes, while the annual requirement is about 7000 tonnes (Baghel, *et al*. 2010) [1]. Therefore, it is need to increase cultivation of Ashwagandha for higher production. Leaf spot disease of Ashwagandha caused by *Alternaria alternate* is most prevalent disease. It was first reported by Pandey and Nigam (1985) [5]. This disease has been causing considerable damage to the commercial fields of Ashwagandha during warm and humid climatic conditions. Severe infection often leads serious defoliation and substantial biodeterioration of its pharmaceutically important constituents (Pati *et al*., 2008) [7]. Spray of Fungicides is one of common management practices but repeated use of fungicide lead to development of fungicides resistance. This situation triggered interest in secondary alternative for disease management. Biopesticides are potential candidate that can be used against phytopathogenic fungi. The crude extracts of plants and cow products have shown inhibitory activities against plant pathogenic fungi. Hence, the objective behind these experiments was to study the effect of bio agents and cow products on leaf spot infection, growth and yield of Ashwagandha.

Materials and Methods
Field experiment was conducted in sandy loam soil, the plot size 3.6 X 3.0 m^2 adopting a standard spacing 30 X 10 cm for Ashwagandha sowing. Farm yard manures (FYM) 10 tones / ha was mixed in the soil before sowing. The variety Nagori was sown (@5 g seed/plot with 13 treatments *viz*; T_1- Three foliar spray of ridomil MZ @ 0.25% concentration at 45, 60 and 90 days after sowing, T_2- Three foliar spray of Streptocycline sulphate @ 0.30% concentration at 45, 60 and 90 days after sowing, T_3- Three foliar spray of Antracol (Propineb) @ 0.20% concentration at 45, 60 and 90 days after sowing, T_4- Three foliar spray of Kovach

(Chlorothalonil) @ 0.20% concentration at 45, 60 and 90 days after sowing, T_5- Three foliar spray of Bayleton (Triodemefon) @ 0.05% concentration at 45, 60 and 90 days after sowing, T_6- Three foliar spray of Metalaxyl @ 0.25% concentration at 45, 60 and 90 days after sowing, T_7- Three foliar spray of *P. fluorescens* @ 0.20% concentration at 45, 60 and 90 days after sowing, T_8- Three foliar spray of *Trichoderma harzianum* @ 0.20% concentration at 45, 60 and 90 days after sowing, T_9- Three foliar spray of Cow urine @ 10% concentration at 45, 60 and 90 days after sowing, T_{10}- Three foliar spray of Cow dung slurry @ 10% concentration at 45, 60 and 90 days after sowing, T_{11}- Three foliar spray of Panchgavya @ 10% concentration at 45, 60 and 90 days after sowing, T_{12}- Three foliar spray of Vanaspativash @ 10% concentration at 45, 60 and 90 days after sowing, T_{13}- Control. Three replication in randomized block design were maintained for each treatments. Percent disease intensity (PDI) of *Alternaria* leaf spot disease was scored in the field at 6th, 9th and 12th standard week in randomly selected three plants of each Ashwagandha plots. The percentage of leaves affected by disease was assessed visually in 0- 4 point scale as described by Meena *et al*; (2019) [3]. Observations were made growth and yield parameters and data were analized based on the method suggested by Panse and Sukhatme (1961) [6].

Results and Discussions

Perusal of the table (1) revealed that the effect of the treatments were significantly reducing the percent disease intensity. The reduction was maximum in Ridomil MZ (4.80%) followed by Kovach (4.93%), Antracoal (5.30%), Streptocycline sulphate (6.93%), Bayleton (7.47%) and Metalaxyl (8.07%) at 10 days after 1st spray. 10 days after second spray, the lowest disease intensity was recorded in Kovach (8.40%) followed by Redomil (8.53%, Antracoal (10.80%) and Streptocycline sulphate (11.47%). 10 days after 3rd spray, minimum percent disease intensity was observed in Redomil (17.70%) followed by Kovach (19.20%), Antraconal (20.07%) and Streptocycline sulphate (24.07%). The effect of fungicide on percent disease intensity was found highest in comparison to organic treatments. Percent disease control was recorded maximum in ridomil MZ (65.78) followed by kavach (64.12) and antracol (60.15). In case of organics, highest control was found in P. *fluorescens* (34.74%) followed by *Trichoderma harzianum (31.75%)* and Panchgavya (31.03%).

Although, bioagents and cow products were significantly minimized the percent disease intensity in comparison to control after all spray schedule. The effect between bioagents and cow product were found not significant except *pseudomonas fluorescence* after Ist and IInd spray and Panchgavya after 3rd spray. Three sprays of kavach (0.2%) were found next to two sprays of ridomil MZ at 60 and 80 DAS (Yadav, 2003) [8]. Bhargava *et al*., (1997) [2] reported that kavach was superior to ridomil MZ when sprayed at 20, 40 and 60 DAS. This might be due to better efficacy of kavach at lower inoculums load. Results of experiment in table-2 showed the significant effect of fungicides, bioagents and cow products on growth and yield of *withania somnifera*. The effect of treatments on plant height were significantly higher in Kovach (86.56 cm) followed by Antracol (83.88 cm), cow urine (82.56 cm), *Trichoderma harzianum* (80.21 cm) and Redomil (79.22 cm). In between the treatments, effect was not significant. In case of number of branching, the effect was recorded highest in cow urine (5.22) followed by *Trichoderma harzianum* (4.99), Redomil (4.99) and Kovach (4.69). The minimum effect was observed in cow dung slurry (3.62) and Antracol (3.78) in comparison to control (2.87). Number of leaves were recorded significantly higher in Redomil (69.89) followed by Kovach (69.72), panchgavya (66.33), cow urine (62.83) and *Trichoderma harzianum* (62.10). Average numbers of leaves were recorded 40.66 in control. Highest root length was recorded in Kovach (39.83 cm) and lowest in control (31.24 cm). Stem fresh weight was found highest in Kovach (118.87 g) followed by Trichoderma (113.30g) Redomil (102.22 g), and cow urine (95.53 g). The fresh weight of leaves was recorded maximum in Redomil (69.98 g) followed by Kovach (68.30), *Trichoderma* (65.50g) and cow urine (64.97 g). Fresh weight of root was found maximum in Kovach (43.30 g) followed by Redomil (41.08 g) cow urine (40.40 g) and *Trichoderma harzianum* (35.40 g). The number of berry per plants was recorded highest in Kovach (81.67) followed by *Trichoderma* (80.10), cow urine (76.33) and Redomil (74.33). Average number of berry per plants was found 55.07 in control. The effect of all treatments on the seed yield per plot was observed significantly higher in comparison to control. The maximum seed yield per plot was observed in Ridomil (0.670 kg) followed by Kovach (0.672 kg), Trichoderma harzianum (0.671 kg) and panchgavya (0.671 kg). Yadav (2003) [8] recorded maximum yield in antracol spray followed by ridomil MZ in mustard infected with Alternaria blight. The is due to organic product stimulate the production of growth promoting substances by the microbial inoculants which lead to better root proliferation, uptake of nutrients, water and higher number of leaves for more photosynthesis. Similar results have been reported by Naidu *et al.* (2002) [4] in brinjal.

Table 1: Effect of fungicides and organics on the Alternaria leaf spot disease of Ashwagandha

Treatments	Dose (%)	Percent Disease Intensity			Mean	Percent control
		1st spray at 6th week	2nd spray at 9th week	3rd spray at 12th week		
Ridomil MZ	0.25	4.80 (12.65)	8.53 (16.97)	17.70 (24.88)	10.34	65.78
Streptocycline sulphate	0.30	6.93 (15.26)	11.47 (19.78)	24.07 (29.38)	14.15	53.17
Antracol (propineb)	0.20	5.30 (13.28)	10.80 (19.18)	20.07 (26.58)	12.04	60.15
Kovach (Chlorothalonil)	0.20	4.93 (12.81)	8.40 (16.83)	19.20 (25.99)	10.84	64.12
Bayleton (Triodimefon)	0.05	7.47 (15.82)	13.33 (21.41)	27.90 (31.88)	16.23	46.29
Metalaxyl	0.25	8.07 (16.48)	13.33 (21.41)	31.20 (33.96)	14.20	53.01
Pseudomonas fluorescence	0.50	10.43 (18.83)	15.53 (23.17)	33.20 (35.18)	19.72	34.74
Trichoderma harzianum	0.50	12.90 (21.03)	16.06 (23.60)	32.90 (35.00)	20.62	31.76
Cow urine	10.0	12.57 (20.75)	17.37 (24.60)	34.53 (35.99)	21.49	28.88
Cow dung slurry	10.0	13.40 (21.46)	19.43 (26.15)	35.97 (36.84)	22.93	24.12
Panchgavya	10.0	13.20 (21.30)	18.17 (25.23)	31.17 (34.55)	20.84	31.03
Vanaspativash	10.0	13.30 (21.37)	20.13 (26.66)	36.00 (36.87)	23.14	23.42
Control	Water	17.23 (24.50)	31.23 (33.98)	42.20 (40.51)	30.22	-

S.Em∓		0.0581	0.581	0.470	-	-
CD at 5%		1.695	1.695	1.372	-	-
CV%		5.550	4.287	2.476	-	-

Table 2: Effect of fungicides and organics on the biomass yield of Ashwagandha

Treatments	Dose (%)	Growth characters				Fresh weight (g)			Dry weight (g)			No of berries/plant	Seed yield (kg)/plot
		Plant height (cm)	No. of branch/ plant	No. of leaves/ plant	Root length (cm)	Leaves	Stem	Root	Leaves	Stem	Root		
Ridomil MZ	0.25	79.22	4.99	69.89	38.97	69.98	102.22	41.08	7.2	11.33	5.9	74.33	0.678
Streptocycline sulphate	0.30	75.11	4.67	54.54	34.23	41.11	63.83	30.53	5.1	7.81	4.6	62.00	0.592
Antracol (propineb)	0.20	83.88	3.78	61.98	37.44	43.88	95.07	30.53	5.9	9.85	4.7	60.00	0.594
Kovach (Chlorothalonil)	0.20	86.56	4.69	69.72	39.83	68.30	118.87	43.30	7.0	11.9	5.1	81.67	0.672
Bayleton (Triodimefon)	0.05	71.22	3.89	56.01	38.88	56.07	80.53	34.80	5.3	9.5	4.8	69.00	0.589
Metalaxyl	0.25	76.88	4.10	56.67	33.60	62.73	80.50	34.07	6.6	9.7	4.8	64.0067.67	0.640
Pseudomonas fluorescence	0.50	79.10	4.00	60.76	36.30	62.73	85.53	35.40	6.6	9.9	4.8	80.10	0.668
Trichoderma harzianum	0.50	80.21	4.99	62.10	33.73	65.50	113.30	36.07	6.4	11.4	4.1	76.33	0.671
Cow urine	10.0	82.56	5.22	62.83	36.36	64.97	95.53	40.40	6.3	10.1	5.3	67.00	0.670
Cow dung slurry	10.0	76.33	3.67	59.22	35.50	59.43	94.00	32.33	6.9	9.8	4.1	66.33	0.658
Panchgavya	10.0	78.99	4.57	66.33	35.59	60.50	93.83	33.30	6.1	9.6	4.4	56.82	0.671
Vanaspativash	10.0	76.70	4.12	61.42	33.43	65.40	90.53	31.97	6.4	9.5	4.5	55.67	0.664
Control	Water	49.56	2.87	40.66	31.24	33.97	56.50	2.205	3.9	5.8	3.6	2.115	0.546
S.Em∓		3.210	0.261	1.673	1.113	2.791	3.372	6.435	0.268	0.425	0.191	6.174	0.172
CD at 5%		9.370	0.761	4.779	3.306	8.149	9.841		0.782	1.239	0.558		0.526

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