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Management of black rot of cabbage and cauliflower by seed treatment, root dipping and foliar spray of antibiotics and biocontrol agents

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Cabbage and cauliflower are important cole crops grown in India, accounting for about ten percent of the total vegetable production of the country (Anon, 2011). Black rot caused by *Xanthomonas campestris* pv *campestris* (Pammel) Dowson is one of the causes which limit the commercial production of the crops. The bacteria can attack the crops at both seedling and planting stages and the infection results from infected seeds. Due to the diseases, there is an extensive loss in the field and quality of curds and yield as well as vigour of the seed crop (Kashyap and Dhiman, 2009). Under severe attack of this disease, substantial reduction in the yield to the tune of 5 to 70% has been reported (Sharma and Ramchandra, 1991). Management of the disease is restricted to use of resistant cultivars, hot water treatment of seeds followed by application of antibiotics or protectant fungicides (Hilderbrand, 1994), but the control has been only partial. Keeping this at the backdrop an effort was directed to use seed treatment, root dipping, antibiotics and spray of bactericides and bio-control agents in combination as well as in solo for the management of the menace, under field conditions.

Field trials under the All India Co-ordinate Research Project on Vegetable Crops were conducted at the Research farm, Indian Institute of Vegetable Research, Varanasi during Rabi seasons of 2008-09, 2009-10 and 2010-11. The crop was sown in end November with a spacing of 20 cm× 15 cm. The plot size was 2.4 m × 2.4m. The varieties used were 'Hajipur local' of cabbage and cauliflower respectively. Twelve treatments comprising of hot water seed treatment, seed treatment with streptomycin sulphate and *Pseudomonas fluorescens*, combination of seed treatment and spraying with streptomycin sulphate, copper oxychloride, and *Pseudomonas fluorescens*, and combination of seed treatments, root dipping and foliar spray, both with *Pseudomonas fluorescens* were evaluated diseases. The treatments were laid down in RBD with three replications. First spraying was done when initial symptoms of the disease were observed during third week of January. Observations of disease were taken when the untreated control showed maximum infection, using the scale, 0-5 (Kashyap and Dhiman, 2010).

The results of field experiments revealed that black rot disease intensity was significantly less in both cabbage and cauliflower when seeds were treated with streptomycin sulphate @ 100ppm followed by two sprays of streptomycin sulphate @ 100ppm at 12 days interval. The mean percent disease index (PDI) of three seasons as exhibited by the aforesaid treatment in case of cabbage and cauliflower was 4.9 and 5.1 respectively, as compared to untreated control exhibiting a PDI of 30.8 and 27.3 respectively Table 1 and 2). This was followed by seed treatment with hot water at 50^{o}C for 10 minute followed by two sprays of streptomycin sulphate @ 100ppm at 12 days interval manifesting a PDI of 6.9 and 7.1 in cabbage and cauliflower respectively. Yield data also exhibited a similar trend where the aforementioned best treatment recorded 35.4% and 50% higher yield of cabbage and cauliflower respectively as compared to untreated control (Table 1 and 2). Streptocycline and copper based compounds are generally recommended against black rot (Jorgensen and Walter, 1995) and hot water treatment at 122^{o}F for 25 minutes was also reported to be equally effective against the disease (Delahaut and Stevenson, 2004). The present investigation conform to the above findings and the combination of both seed treatment and foliar spray of streptomycin sulphate, which was found effective for three consecutive seasons may be recommended against the diseases.

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Table 1: Effect of different treatments on black rot of cabbage

Treatment	PDI			Mean	Percent disease control	Yield (q/ha)			Mean	Percent yield increase
	2008-9	2009-10	2010-11			2008-9	2009-10	2010-11		
T1:Hot water treatment at 50° C for 10 minutes	20.2	21.6	20.1	20.6	33.0	589.2	592.4	585.3	588.9	10.5
T2:Seed treatment with streptomycin sulphate@100ppm	15	16.2	15.2	15.4	49.8	607.2	611.5	608.3	609.0	14.3
T3:Seed treatment with *Pseudomonas fluorescens*@5g/kg of seed	16.8	17.1	17.2	17.0	44.8	601	603.7	604.5	603.0	13.2
T4:T1+ Spraying with streptomycin sulphate@100ppm for two times at 12 days interval.	6.7	6.8	7.3	6.9	77.5	696.4	701.2	700.3	699.3	31.3
T5:T1+ one spraying with streptomycin sulphate@100ppm +copper oxychloride@0.3%	10.8	9.7	11.1	10.5	65.8	689.4	690.2	692.5	690.7	29.7
T6:T1+root dipping(1g/l)+foliar spray with *Pseudomonas fluorescens* @5%	15.6	15.2	15.8	15.5	49.7	606.6	608.1	605.7	606.8	13.9
T7:T2+ Spraying with streptomycin sulphate@100ppm for two times at 12 days interval	4.5	4.6	5.8	4.9	83.9	736.2	740.1	688.3	721.5	35.4
T8:T2+ one spraying with streptomycin sulphate@100ppm +copper oxychloride@0.3%	10.2	8.7	11.3	10.0	67.4	689.7	692.1	685.6	689.1	29.4
T9:T2+root dipping(1g/l)+foliar spray with *Pseudomonas fluorescens* @5%	13.8	13.4	13.9	13.7	55.5	610.6	612.6	605.3	609.5	14.4
T10:T3+ Spraying with streptomycin sulphate@100ppm for two times at 12 days interval	14.9	15.3	16.1	15.4	49.9	608.9	610.5	601.2	606.8	13.9
T11:T3+ one spraying with streptomycin sulphate@100ppm +copper oxychloride@0.3%	17.5	17.7	17.8	17.6	42.7	597.2	598.6	594.5	596.76	12.0
T12:T2+root dipping(1g/l)+foliar spray with *Pseudomonas fluorescens* @5%	18.6	18.3	19.2	18.7	39.3	594.5	595.2	595.1	594.9	11.67
T13:Control	30.7	29.2	32.6	30.8	-	532.4	538.6	527.2	532.7	-
CD@0.05	3.8	4.1	2.3	-	-	7.7	7.2	9.4	-	-
CV@0.05	3.4	3.9	3.3	-	-	9.2	9.7	9.5	-	-
SEm±	1.1	1.6	0.94	-	-	2.2	2.5	3.1	-	-

Table 2: Effect of different treatments on black rot of cauliflower

Treatment	PDI			Mean	Percent disease control	Yield			Mean	Percent yield increase
	2008-9	2009-10	2010-11			2008-9	2009-10	2010-11		
T1:Hot water treatment at 50° C for 10 minutes	18.4	19.2	18.6	18.7	31.4	331.8	327.4	326.4	328.5	12.7
T2:Seed treatment with streptomycin sulphate@100ppm	14.1	13.8	15.3	14.4	47.3	371.1	378.6	364.3	371.3	27.4
T3: Seed treatment with *Pseudomonas fluorescens*@5g/kg of seed	16	16.8	16.1	16.3	40.3	347.4	369.3	359.2	358.6	23.0
T4:T1+ Spraying with streptomycin sulphate@100ppm for two times at 12 days interval.	7.8	6.2	7.3	7.1	74.0	399.5	402.9	398.7	400.3	37.3
T5: T1+ one spraying with streptomycin sulphate@100ppm +copper oxychloride@0.3%	10.4	9.8	11.3	10.5	61.5	382.9	394.2	385.2	387.4	32.9
T6:T1+root dipping(1g/l)+foliar spray with *Pseudomonas fluorescens* @5%	15.9	15.2	16.6	15.9	41.8	353.2	371.1	357.5	360.6	23.7
T7:T2+ Spraying with streptomycin sulphate@100ppm for two times at 12 days interval	5.1	4.8	5.5	5.1	81.2	434.6	442.1	435.2	437.3	50.0
T8:T2+ one spraying with streptomycin sulphate@100ppm +copper oxychloride@0.3%	9.4	7.9	8.3	8.5	68.7	389.6	394.7	397.3	393.8	35.1
T9: T2+root dipping(1g/l)+foliar spray with *Pseudomonas fluorescens* @5%	13.5	12.6	12.8	12.9	52.5	362.4	374.8	376.4	371.2	27.3
T10:T3+ Spraying with streptomycin sulphate@100ppm for two times at 12 days interval	15.2	16.3	16.8	16.1	41.0	354.3	351.5	350.3	352.0	20.7
T11: T3+ one spraying with streptomycin sulphate@100ppm +copper oxychloride@0.3%	16.4	17.1	17.2	16.9	38.1	348.1	353.7	345.1	348.9	19.7
T12:T2+root dipping(1g/l)+foliar spray with *Pseudomonas fluorescens* @5%	17.4	18.2	18.4	18	34.1	334.1	341.2	336.8	337.3	15.7
T13: Control	28.8	23.2	29.7	27.3	-	290.1	292.6	291.6	291.4	-
CD@0.05	3.7	4.8	4.3	-	-	6.3	6.2	5.1	-	-
CV@0.05	3.8	4.1	4.3	-	-	5.8	7.8	6.3	-	-
SEm±	1.0	1.4	1.3	-	-	2.2	2.1	1.9	-	-

N. B. - Data was arcsine transformed prior to analysis

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