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Effect of selected bio-resources on purple blotch disease of onion (*Allium cepa* L.)

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Abstract
Onion (*Allium cepa* L.) which is also called as "bulb onion", "Queen of kitchen" or "Princess of vegetables", is one of the important cultivated crops belonging to the genus Allium and family Amaryllidaceae. Purple blotch of onion which is caused by *Alternaria porri* is major disease in the onion. The silkworm excreta, *Trichoderma viride, Pseudomonas fluorescens* and neem oil were tested under field conditions during *Rabi* 2020- 2021 for their efficacy against the disease and growth & yield parameters. A survey was conducted during *Rabi* 2020 to know the severity of purple blotch of onion in farmer's fields in Anantapur district of Andhra Pradesh. Eight villages were selected in the district and in each village five fields were surveyed. The disease severity ranged from 23.22 to 48.39 per cent irrespective of location surveyed. The disease severity was least in Sanipalli village (23.22%) during December 2020 and highest in Venkatapuram village (48.39%) during the month of December 2020. Among the treatments the plant height (cm) at 90 DAT significantly increased in T_4 – *Trichoderma viride*+ *Pseudomonas fluorescens*+ silkworm excreta (38.0 cm) followed by T_1 – *Pseudomonas fluorescens*+ silkworm excreta (28.6 cm). The weight of bulb significantly increased in T_4 – *Trichoderma viride*+ *Pseudomonas fluorescens*+ silkworm excreta (53.6 gm) followed by T_3 – neem oil (46.3 gm). The bulb diameter (3.6) and yield (15.3 q/acre) significantly increased in T_4 – *Trichoderma viride*+ *Pseudomonas fluorescens*+ silkworm excreta followed by T_2 – *Trichoderma viride*+ silkworm excreta. Disease intensity (%) at 90 DAT (27.8%) significantly decreased in T_4 – *Trichoderma viride*+ *Pseudomonas fluorescens*+ silkworm excreta followed by T_2 – *Trichoderma viride*+ silkworm excreta. Higher gross return value (Rs. 27,134.1/acre), net return value (Rs. 14,334/acre), and B:C Ratio (2.11) was found in the treatment T_4 – *Trichoderma viride*+ *Pseudomonas fluorescens*+ silkworm excreta as compared to untreated check control T_0 – (1.20).

Keywords: *Alternaria porri*, neem oil, *Pseudomonas fluorescens*, purple blotch of onion, *Trichoderma viride*

Introduction
Onion (*Allium cepa* L.) which is also called as "bulb onion", "Queen of Kitchen" or "Princess of vegetables", is one of the important cultivated crops belonging to the genus Allium and family Amaryllidaceae and originates from Western Asia, i.e. Turkestan and Afghanistan.
Onions are grown in every part of the world where plants are cultivated and can be grown from seeds, bulbs or sets. It shows great variation in many characteristics such as size, colour, shape and pungency (Griffiths *et al.*, 2002) [8]. Onion has great economic importance due to its medicinal and dietetic values (Chakraborty *et al.*, 2015) [4]. Onion contains a lachrymatic agent, a strong antibiotic in addition to fungicidal, anti-bacterial, anti-cholesterol, anti-cancer and anti-oxidant components such as quercetin (Baghizadeh *et al.*, 2009) [2]. In addition, it is to be rich in phytochemicals especially flavonols which are of medicinal (Javadzadeh *et al.*, 2009) [11].
Onion is an extensively grown biennial bulb crop, with world production of 93,226,400 tonnes produced per year. China and India are the primary onion growing countries. Maharashtra and Karnataka ranked the highest for the production of onions during the measured time period. The major onion producing states are Maharashtra, Madhya Pradesh, Karnataka, Rajasthan, Bihar, Gujarat, Andhra Pradesh, Haryana, West Bengal and Uttar Pradesh in the country. These states account for almost 90% of the total onion production in the country (Anonymous, 2020) [1].
Among the diseases, Purple blotch (*Alternaria porri*) is one of the major constraints in onion cultivation. The causal organism of disease is *Alternaria porri*. The symptoms are water-soaked lesions with small white centres. Lesions usually appear on older leaves and become purple with yellow concentric rings on the margins as the disease progresses.

The spore germination, infection and symptom production had a wide optimum temperature range of 21-30 ºC. High relative humidity favoured the appearance of typical purple blotch while low relative humidity resulted in white flecks, which were often sterile. Temperature and relative humidity resulted in white flecks, which were often sterile. Temperature and relative humidity play a vital role in disease development of purple blotch (Bock, 1964) [3].
The silkworm excrement-derived organic fertilizer improves the yield and quality of crops and significantly amends the acidity and fertility of soil (Chen *et al.*, 2011) [5]. Excrements of silkworms increase the soil-available nutrients and organic matter content, soil enzyme activities in much greater quantities than the goat feces (Yang *et al.*, 2016) [16].
The control strategies of purple blotch are use of silkworm excreta, neem oil and bio-agents. One such attempt has been made to evaluate the effect of bio-resources against Purple blotch of onion (*Alternaria porri*) *in vivo*.

Materials and Methods
Experimental site
The experiment was conducted at Farmer's field, Penukonda, Anantapur, Andhra Pradesh during *Rabi* season 2020-2021.

Methodology
Collection of disease samples
Plants showing typical symptoms, in the field of standing crop i.e., the infected leaf of onion were selected. These disease plant materials were brought to the lab for further investigation.

Fig 1: Appearance of disease

Identification of the fungus by slide preparation
Examination of the fungal colony characteristics was done through microscopic examination. Using a sterile needle, a small portion of the infected plant part was taken and placed on a sterile glass slide. It was stained using lactophenol and cotton blue and covered with the coverslip. Then, the microscope was used for the examination of morphological characteristics of fungal structures (Grahovac *et al.*, 2012) [7].

Morphological characters of *Alternaria porri*
Conidiophores arising singly or in small groups, pale to mid brown. Conidia single, straight or slightly curved, obclavate or with body of conidium ellipsoidal and tapering to a beak, 8-12 transverse septa, 0-7 longitudinal or oblique septa, sometimes slightly constricted at septa, beak is often about same length as body of conidium. It is sometimes branched, pale coloured, 2-4 µm thick, tapering (Mohammad *et al.*, 2016) [13].

Fig 2: Microscopic view under 40X magnification

Evaluation of bio-resources *in vivo*
The efficacy of non-systemic fungicide, bio-agents and neem oil against *Alternaria porrii* was carried out in field condition.

Disease intensity (%)
Disease intensity (%) formula was given by Wheeler (1969) [15].
It is calculated by using the following formula:

$$\text{Disease intensity (\%)} = \frac{\text{Sum of all disease ratings}}{\text{Total number of ratings} \times \text{Maximum disease grade}} \times 100$$

Observations recorded
Pre-harvest and post-harvest observations were recorded during the course of experiment. Pre-harvest observations were plant height (cm), weight of bulb (gm), bulb diameter, disease intensity and post-harvest observations were yield (q/ha) and B:C ratio.

Results and Discussion

Table 1: Survey for the disease severity of Purple blotch of onion in Anantapur district region of Andhra Pradesh

Sr. No	Village	Farmers Name	Area	Variety	Mean Disease Intensity (%)
1	Penukonda	Venkatesh	1 acre	Pusa Red	35.56
2	Somandepalli	Suresh	1 acre	Pusa Red	33.43
3	Sanipalli	Narayana	1.5 acre	Bhima Red	23.22
4	Kondampalli	Munikanna	0.4 acre	Bhima Red	38.35
5	Islapuram	Sundaramma	1 acre	Pusa Red	31.56
6	Gollapalli	Seenappa	1.2 acre	Local Variety	28.41
7	Chennekothapalli	Sreekant	0.5 acre	Local Variety	30.89
8	Venkatapuram	Manisharma	0.6 acre	Pusa Red	48.39
Mean PDI					33.476

Survey

The disease severity ranged from 23.22 to 48.39 per cent irrespective of location surveyed. The disease severity was least Sanipalli village (23.22%) during December 2020 and highest in Venkatapuram village (48.39%) during the month of December 2020.

Fig 3: Survey of onion fields in different regions of Anantapur, Andhra Pradesh

Table 2: Effect of bio-resources on plant height (cm) and disease intensity (%)

Tr. No.	Treatments	Plant height (cm)			Disease Intensity (%)		
		30 DAT	60 DAT	90 DAT	30 DAT	45 DAT	60 DAT
T_0	Control (untreated check) + silkworm excreta	12.2	13.0	18.0	18.3	27.7	42.0
T_1	*Pseudomonas fluorescens*+ silkworm excreta	22.3	25.0	28.6	14.2	21.9	34.9
T_2	*Trichoderma viride*+ silkworm excreta	16.5	22.0	25.0	16.6	24.1	33.9
T_3	Neem oil+ silkworm excreta	13.0	16.0	21.0	19.0	24.7	37.4
T_4	*P. fluorescens*+ *T. viride*+ silkworm excreta	25.3	33.0	38.0	17.1	19.8	27.8
T_5	Carbendazim+ silkworm excreta	33.6	38.6	45.3	14.6	18.6	22.6
S.Ed.(±)		1.91	1.35	1.29	1.06	1.27	1.64
CD (5%)		4.28	3.00	2.87	2.39	2.82	3.65

Plant height (cm)

The plant height of onion significantly increased in treatment T_4 – *P. fluorescens*+ *T. viride*+ silkworm excreta followed by T_1 – *Pseudomonas fluorescens*+ silkworm excreta, T_2 – *Trichoderma viride*+ silkworm excreta and T_3 – neem oil+ silkworm excreta as compared to T_5 – carbendazim+ silkworm excreta and untreated control T_0.

Disease intensity (%)

The disease intensity (%) significantly decreased in treatment T_4 – *P. fluorescens*+ *T. viride*+ silkworm excreta followed by T_2 – *Trichoderma viride*+ silkworm excreta, T_1 – *Pseudomonas fluorescens*+ silkworm excreta and T_3 – neem oil+ silkworm excreta as compared to T_5 – carbendazim+ silkworm excreta and significantly increased in untreated control T_0. Among the treatments, (T_2, T_1, T_3) and (T_1 and T_3) were found significant to each other.

Fig 4: Disease scale

Table 3: Effect of bio-resources on weight of bulb (g), bulb diameter, yield (q/acre) and B:C ratio

Tr. No.	Treatments	Weight of bulb (g)	Bulb Diameter	Yield (q/acre)	B:C Ratio
T_0	Control (untreated check) + silkworm excreta	15.6	1.4	6.2	1.20
T_1	*Pseudomonas fluorescens*+ silkworm excreta	36.9	2.5	10.9	1.38
T_2	*Trichoderma viride*+ silkworm excreta	24.6	3.0	12.2	1.72
T_3	Neem oil+ silkworm excreta	46.3	2.3	9.2	1.21
T_4	*P. fluorescens*+ *T. viride*+ silkworm excreta	53.9	3.6	15.3	2.11
T_5	Carbendazim+ silkworm excreta	48.0	4.3	16.9	2.43
S.Ed. (±)		1.98	0.21	0.39	
CD (5%)		4.43	0.47	0.85	

Weight of bulb (gm)
The weight of bulb of onions significantly increased in treatment T_4 – *P. fluorescens*+ *T. viride*+ silkworm excreta (53.6 gm) followed by T_3 – neem oil+ silkworm excreta (46.3 gm), T_1 – *Pseudomonas fluorescens*+ silkworm excreta (36.9 gm) and T_2 – *Trichoderma viride*+ silkworm excreta (24.6 gm) as compared to T_5 – carbendazim+ silkworm excreta (48.0 gm) and untreated control T_0 – (15.6 gm). Among the treatments, T_1 and T_5 were found non – significant to each other.

Bulb diameter
The bulb diameter of onions significantly increased in treatment T_4 – *P. fluorescens*+ *T.viride*+ silkworm excreta followed by T_2 – *Trichoderma viride*+ silkworm excreta, T_1 – *Pseudomonas fluorescens*+ silkworm excreta and T_3 – neem oil+ silkworm excreta as compared to T_5 – carbendazim+ silkworm excreta (4.3) and untreated control T_0. Among the treatments, (T_3, T_1), (T_1, T_2) and (T_4, T_5) were found non – significant to each other.

Yield (q/acre)
The total yield of onion significantly increased in treatment T_4 – *P. fluorescens*+ *T. viride*+ silkworm excreta followed by T_2 – *Trichoderma viride*+ silkworm excreta, T_1 – *Pseudomonas fluorescens*+ silkworm excreta and T_3 – neem oil+ silkworm excreta as compared to T_5 – carbendazim+ silkworm excreta and untreated control T_0.

Fig 5: Onions at harvesting stage

Results of benefit cost ratio among the treatments were observed. The cost of cultivation (Rs. 12,800/acre) and the highest gross returns (Rs. 27,134.1/acre) and net returns (Rs. 14,334/acre) were recorded in treatment T_4. The lowest was observed in untreated control with T_0 with gross returns (Rs. 9200/acre), cost of cultivation (Rs. 11080.2/acre) and net returns (Rs. 1880/acre).

Discussion
Chetana and Harun (2015) [10] in the study revealed that silkworm excreta promote plant growth by suppressing pathogenic micro-organisms. *Trichoderma* species produced secondary metabolites such as antibiotics, iso-cyanide, acids, peptaibols and cell wall degrading enzymes which are implicated in the growth inhibition of many phytopathogenic fungi (Hariprasad *et al.*, 2021) [9]. Prakasam and Sharma (2012) [14] reported that bulb diameter was increased and found anti-fungal compounds in onion bulb grown with *Trichoderma* treatment. *Pseudomonas fluorescens* have been shown to be potential agents for the bio-control which suppress plant diseases by protecting the seeds and roots from fungal infection (Kakraliya *et al.*, 2017) [12].
Probable reasons for such findings may be due to the use of silkworm excreta as a good source of farm manure, due to their content of essential nutrients for plants. It may have promoted plant growth by suppressing pathogenic micro-organisms. Excrements of silkworms increase the soil-available nutrients and organic matter content, soil enzyme activities. *Trichoderma* species possess many qualities and they have great potential use in agriculture such as amend abiotic stresses, improving physiological response to stresses, alleviating uptake of nutrients in plants, enhancing nitrogen-use efficiency in different crops, and assisting to improve photosynthetic efficiency. Pseudomonas promotes plant growth by suppressing pathogenic micro-organisms, synthesizing growth-stimulating plant hormones and promoting increased plant disease resistance. Neem oil prevents the germination and penetration of some fungal spores. It can be used as a viable and sustainable alternative for the control of Alternaria species. Trichoderma helps in secretion of extra cellular enzymes, penetrations of the hyphae and lysis of the host.

Conclusions
From the present study, bio-agents, silkworm excreta and neem oil have strong antimicrobial activities which are identified against *Alternaria porri*. It is concluded that among treatments, the plant height (cm) (38.0 cm), weight of bulb (53.9 g), bulb diameter (3.6), yield (15.3 q/acre), B:C ratio (2.11) significantly increased and disease intensity (%) (27.8%) significantly decreased in T_4- *Pseudomonas fluorescens* + *Trichoderma viride* + silkworm excreta. Applying silkworm excreta, bio-agents and spraying of neem oil in the field would be considered as beneficial and eco-friendly. However, the present study was limited to one crop season i.e., *rabi* season under Penukonda, Anantapur conditions, therefore, to substantiate the present result more trials are needed for 2-3 seasons for further recommendations.

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