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Effective management of bacterial wilt disease in potato

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Field trials were conducted with six treatments and four replications in the Research Farm under All India Co-ordinated Research Project on Potato, Odisha University of Agriculture & Technology, Bhubaneswar-3, Odisha during winter season in three consecutive years 2018-19, 2019-2020 and 2020-2021. The bacterial wilt incidence was recorded at 60 days after planting and tuber yield was recorded at the time of harvest,i.e.75 days after planting. Based on the average of three years' experimental data, lowest wilt incidence of 3.63% was recorded from the treatment with soil application of bleaching powder@ 20 kg /ha (50% at the time of planting & 50% at the time of earthing up) which revealed 74.66 % decrease in wilt incidence over control. Maximum cost benefit ratio was also obtained from soil application of bleaching powder@ 20 kg /ha (3.30) followed by soil application of stable bleaching powder @ 12 kg/ha (50% at the time of planting & 50% at the time of earthing up) (3.08).

Keywords : Bacterial wilt, economics, potato

INTRODUCTION

Potato (*Solanum tuberosum* L) is considered as an important food crop in the world with superior protein production per unit area per unit time than rice, wheat and maize. During 2023, the world-wide potato production was 383 million metric tons (FAOSTAT, 2023). Among different countries, China is the highest producer (93.5 million metric tons) followed by India (60.14 million metric tons).

Potatoes are the leading vegetables in terms of consumption followed by onions and tomatoes. These three vegetables are staples in many Indian households. Leading Potato producing states in India are Uttar Pradesh (20.1 million tons), West Bengal (14.5 million tons), Bihar(9.0 million tons), Gujrat (4.02 million tons) and Madhya Pradesh (3.95 million tons). Uttar Pradesh has contributed 33.44% to national production followed by West Bengal (24.1%).

Bihar, Gujarat and Madhya Pradesh contributed 14.96 %, 6.68 % and 5.56 %, respectively to national production. Potato is the most popular vegetable in Odisha. It is usually grown during winter season in all districts of the state and also in kharif season in some tracts of Koraput and Kandhamal districts. The annual production of potato in Odisha is around 3.0 lakh tons from 23.22 thousand hectares and the productivity is nearly 13.0 t/ha against the national average of 22.5 t/ha which contributes <1% to national production. The yield is less than national average because of short winter, unavailability of seed potato tubers in time, disease and pest problems. Different fungal, bacterial and viral diseases like early blight (*Alternaria solani*) Meena *et al*., 2022, late blight (*Phytophthora infestans*), phoma blight (*Phoma sorghina*) (Biswal *et al*, 2023; Biswal and Dhal,2013), bacterial wilt (*Ralstonia solana-cearum*) (Biswal *et al*. 2023; Biswal and Dhal, 2013; Bag and Gurjar, 2018 and Chakraborty and Roy, 2016), black leg (*Pectobacterium carotovorum*), mosaics (PVX,PVY,PVS,PVA) and leaf roll attack the crop in different stages of crop growth (Biswal *et al*,2023; Biswal and Dhal, 2013).

Bacterial wilt can cause globally considerable loss to the crop in different countries like Bangladesh (Chakraborty and Roy, 2016), Kenya

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(Felix *et al*. 2010); Li *et al* (2010),Ethiopia (Tafesse *et al*. 2021, Tessema *et al*. 2020).In India both in growing stage and during storage, this pathogen may cause up to 40 - 60% loss (Biswal and Dhal,2015; Biswal and Dhal,2018). The field trials were conducted in the Research Farm under All India Co-ordinated Research Project on Potato of Odisha University of Agriculture & Technology, Bhubaneswar-3, during winter season in three consecutive years 2018-19, 2019-20 and 2020-21 on "Effective management of bacterial wilt disease in potato" with the variety Kufri Pukhraj.

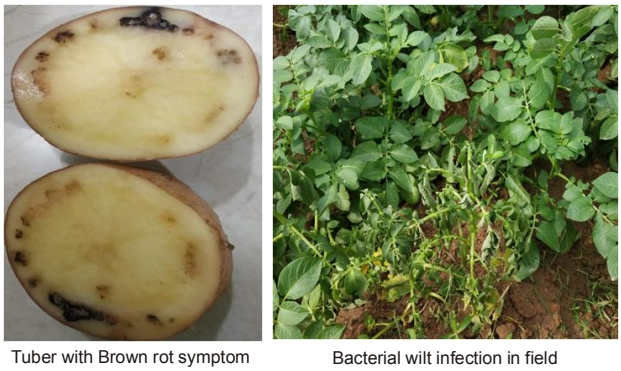
MATERIALS AND METHODS

In the present investigations, the field trials were conducted with six treatments and four replications following Randomized Block Design in the Research Farm under All India Co-ordinated Research Project on Potato of Odisha University of Agriculture & Technology, Bhubaneswar-3, during winter season in three consecutive years 2018-19, 2019-2020 and 2020-2021. The size of each plot was 6 sq.mtr (3m ×2m) and the tubers were planted with spacing 60 cm × 20cm. Different treatments followed in this experiment were: T1- Control, T2- Soil application of stable bleaching powder @ 12 kg/ha (50% at the time of planting & 50% at the time of earthing up), T3- Soil application of stable bleaching powder @ 20 kg/ha (50% at the time of planting & 50% at the time of earthing up), T4- Soil application of *Bacillus subtilis* @ 5kg/ha, T5- Soil application of copper oxychloride @ 4kg/ha at the time of planting, and T6- Drenching with copper oxychloride @ 4kg/ha at the time of earthing up. The well chitted tubers of variety Kufri Pukhraj were used for planting.The bio-agent *Bacillus subtilis* 2% WP (5 X 10^8 CFU/g) was purchased from the local market. It is a bio-agent and also acts as plant growth promoting agent (Almoneafy, 2014). Bleaching powder is composed primarily of Calcium hypochlorite Ca (OCl_2) with 30-40% available chlorine is a strong a strong bleaching and disinfecting agent. It is a mixture of $Ca(OCl_2)$,$Cacl_2$ and $Ca(OH)_2$. Application of bleaching raises the pH levels of acidic soil and inhibits bacterial development and reduces the incidence of wilting (Cai *et al*. 2021)s. Stable bleaching powder is more purer and more stable form of calcium hypochlorite and has stronger action than normal bleaching powder Hence both were used in the field trials. The bacterial wilt incidence was recorded at 60 days after planting and the yield was recorded at the time of harvest ,i.e.75 days after planting. The wilt incidence in the field was calculated by using the following formulae

Wilt Incidence= Numbers of wilted plants x 100
Total number of plants

RESULTS AND DISCUSSION

Symptoms of the disease in the field and of the tuber have been depicted in Fig. 1.The bacterial wilt incidence was recorded at 60 days after planting and yield was recorded at the time of harvest ,i.e.75 days after planting. Average of three years' experimental trials recorded minimum wilt incidence (3.63%) from the treatment T3 (soil application of bleaching powder@ 20 kg /ha ,i.e. 50% at the time of planting & 50% at the time of earthing up) which revealed 74.66 decrease in wilt incidence over control. There was no significant difference in wilt incidence between T3 and T6 (3.63% and 3.83%. respectively). It was followed by T2 (Soil application of bleaching powder @12kg/ha ,i.e. 50% at the time of planting and 50% at the time of earthing up where wilt incidence was recorded



Tuber with Brown rot symptom Bacterial wilt infection in field

Fig.1 : Symptoms of disease affecting potato tuber (left) and the above ground part in the field (right).

as 5.0 % and the percentage of decrease over control was 65.10% (Table 1). Soil application of copper oxychloride @ 4kg/ha (T5) exhibited 5.5% wilt while in *Bacillus subtilis* application(T4) the incidence was 6.83%. The reduction in wilt incidence in both the treatments exhibited 61.61%

Table1: Effect of different treatments on wilt incidence in potato in three years (2018-19, 2019-20 and 2020-21)

Treatments	Wilt Incidence (2018-19)	Wilt Incidence (2019-20)	Wilt Incidence (2020-21)	Average wilt Incidence over three years	Percent Decrease in Wilt Incidence over control
T1=Control	12.75	22.75	7.50	14.33	---
T2=Soil application of stable bleaching powder@12 kg /ha (50% at the time of planting&50% at the time of earthing up)	5.50	7.00	2.50	5.00	65.10
T3=Soil application of stable bleaching powder@ 20 kg /ha (50% at the time of planting&50% at the time of earthing up)	3.14	6.0	1.75	3.63	74.66
T4= Soil application of *Bacillus subtilis*@5kg/ha	5.75	11.0	3.75	6.83	59.31
T5 =Soil application of copper oxychloride @ 4kg /ha at the time of planting	7.25	6..50	2.75.	5.50	61.61
T6=Drenching with copper oxychloride @4kg/ha at the time of earthing up.	1.75	7.25	2.50	3.83	73.27
SE(m)±	0.56	2.01	0.54	0.73	
CD (0.05)	1.22	4.31	1.16	1.57	

and 59.31% decrease over control. Maximum wilt(14.33%) incidence was recorded in control.

The maximum yield (17.72t/ha) was recorded from the treatment T3 (Soil application of bleaching powder@ 20 kg /ha ,i.e. 50% at the time of planting & 50% at the time of earthing up which exhibited 51.35% increase over control (T2).The treatment T2 where soil application of bleaching powder@ 12 kg /ha, i.e. 50% at the time of planting & 50% at the time of earthing up recorded tuber yield of 16.04t/ha which revealed 41.07% increase over control . Use of stable bleaching powder was very effective in managing bacterial wilt of potato (Ghosh and Mandal, 2009). There was no significant difference in yield between T4 (where there was soil application of *Bacillus subtlis* at the time of planting *,i.e.*15.57t/ha) and T6 (application of copper oxychloride at the time of earthing up @4kg/ha,i.e..15.25t/ha). T4 and T6 resulted 36.93% and 34.12 % increase over control. In the treatment T5 where copper oxychloride was applied at the time of earthing up, the yield was 14.31 t/ha which produced 25.85% increase over control. In control, minimum yield (11.37t/ha) was recorded. The effectiveness of bleaching powder has been established previously by several workers (Biswal and Dhal,2018; Biswal *et al*. 2018; Ghosh and Mandal,2009; Sabina *et al*. 2022) and inhibitory effect of*Bacillus subtilis* has been reported earlier against *R. solanacearum* (Abd-El-Khair and Seif El-Nasr,2012)

Maximum benefitand cost ratio was obtained from T3 (3.30) followed by T2(3.08). In T4, it was 2. 9.6 followed by T6 (2.88). In T5, it was 2.71 (Table 3). However, it was observed from (Table1 &2) that minimum wilt (3.63%) incidence and maximum yield (17.72t/ha) were reported from

Table 2: Effect of different treatments on yield of potato in three consecutive years

Treatments	Tuber yield (t/ha)			Average yield over three years (t/ha)	Percent increase in yield over control
	2018-19	2019-20	2020-21		
T1=Control	10.96	12.32	10.83	11.37	-
T2=Soil application of stable bleaching powder@12 kg /ha (50% at the time of planting &50% at the time of earthing up)	18.75	16.45	12.92	16.04	41.07
T3=Soil application of stable bleaching powder@ 20 kg /ha (50% at the time of planting&50% at the time of earthing up)	20.32	17.42	13.94	17.22	51.45
T4= Soil application of *Bacillus subtilis*@5kg/ha	18.80	16.70	11.22	15.57	36.93
T5 =Soil application of copper oxychloride @ 4kg /ha at the time of planting	16.02	14.48	12.43	14.31	25.85
T6=Drenching with copper oxychloride @4kg/ha at the time of earthing up.	17.44	15.28	13.02	15.25	34.12
SE(m)±	0.72	0.64	0.71	0.54	
CD (0.05)	1.62	1.58	2.46	1.74	

the treatment T3 (Soil application of bleaching powder@ 20 kg /ha (50% at the time of planting & 50% at the time of earthing up) which was considered as the most effective in reducing the wilt and also getting more yield. It was followed by T4=Soil application of *Bacillus subtilis*@5kg/ha (6.83 % wilt and 15.57t/ha tuber yield. In control maximum wilt (14.33%) incidence and minimum yield (11.37t/ha) was recorded.

CONCLUSION

The result of these studies concludes that minimum wilt (3.63%) incidence and maximum yield (17.72t/ha) were reported from the treatment ,i.e.soil application of bleaching powder@ 20 kg / ha (50% at the time of planting & 50% at the time of earthing up) which was considered as the most effective in reducing the wilt and also getting more yield. It was followed by the treatment,i.e.soil application of *Bacillus subtilis*@5kg/ha which resulted 6.83 % wilt and 15.57t/ha tuber yield. In control maximum wilt (14.33%) incidence and minimum yield (11.37t/ha) was recorded. However further studies may be carried out on multilocational basis to find out the mechanism of yield enhancement and wilt reduction behaviour is same or not.

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Table 3 : Economics of different treatments

Treatments	Investment (Rs)*	Yield (t/ha)	Return	Benefit :cost ratio
T1=Control	1,30,000	11.37	Rs 2,84,250.00	2.19
T2=Soil application of bleaching powder@12 kg /ha (50% at the time of planting&50% at the time of earthing up)	1,30,240	16.04	Rs 4,01,000.00	3.08
T3=Soil application of bleaching powder@ 20 kg /ha (50% at the time of planting&50% at the time of earthing up)	130,400	17.22	Rs 4,30,500.00	3.30
T4= Soil application of *Bacillus subtilis*@5kg/ha	131450	15.57	Rs.3,89,25.00	2.96
T5 =Soil application of copper oxychloride @ 4kg /ha at the time of planting	132200	14.31	Rs3,57,75.00	2.71
T6=Drenching with copper oxychloride @4kg/ha at the time of earthing up.	132200	15.25	Rs 3,81,250.00	2.88

*Investment cost was calculated on the basis of cost of stable bleaching powder(Rs.20/kg), *Bacillus subtilis*(Rs.229/kg), and copper oxychloride (Rs.550/kg)

DECLARATION

Conflict of Interest. Authors declare no conflict of interest.

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