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# Evaluation of Inorganic Chemicals as Inducer on Yield of Potato against Common Scab Disease Caused by *Streptomyces scabies* (Thaxter) Waksman and Henrichi under glass house condition

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**A B S T R A C T**

Common scab caused by *Streptomyces scabies* (Thaxter) Waksman & Henrici is an important disease worldwide, and can cause significant reduction in the economic value of potato. The management of the disease can be done through conventional methods, biological chemical and cultivation of resistant variety. However, resistance against pathogen is not a permanent solution and fungicidal is not ecofriendly and economical. But new search, induce resistance has taken great attention for plant disease management in near future. Therefore, inquest for induce defense by certain inorganic chemicals like Salicylic acid (10mM), Calcium chloride (10 mM), Hydrogen peroxide (10 ppm), Boric acid (0.1%), Di-potassium hydrogen orthophosphate (0.2 %), Ferric chloride (5mM), Indole acetic acid (1 %), and Copper chloride (10 mM) as inducer were assessed during the course of present investigation. Tuber treatment with inducing agent provide good protection against common scab disease caused by *S. scabies* and also stimulate the germination of seed. Growth promoting effects of the inducers were also perceived. The minimum disease index with 4.45 % were recorded in case of both tuber treatment and foliar spray with salicylic acid as inducer followed by calcium chloride as 4.87 % and boric acid as 5.35% against 9.52 % control-1 and 11.71 % control-2 after harvesting, respectively during 2017-18. The similar trend of observations have also been reported during 2018-19.As per yield is concerned, the highest yield (446.85 g per plant) was recorded from salicylic acid treated plant which is 74.21% and 83.26 %.increase over control-1 and control-2 in year 2017-18. The similar trends of observations have also been reported during 2018-19.Foliar spray with the inducers before pathogen inoculation, protected the plant against infection resulting reduce disease index.

## Introduction

Potato (*Solanum tuberosum* L.) is the most important and leading vegetable crop of the world with immense yield potential giving remunerative income to the farmers and having excellent nutritional values. It is one of the most productive and widely grown food crops in the world and produces approximately twice as many calories per hectare as rice and wheat (Poehlman and Slepper, 1995).

In India, it is the fourth major important food crop after wheat, rice and maize because of its higher yield potential and high nutritive value. The major potato producing country in the world are China (99.06 mMT), India (43.77 mMT), Russia (31.10 mMT), Ukraine (21.75 mMT) and US (19.99 mMT). The total area under potato cultivation in the world is 20.32 million hectares with a production of 480.96 million tons during 2015-16. India produced 51.310 million metric tonne (mMT) of potato from an area of 21.42 lakh hectares of land during 2017-18 (Anonymous, 2018).

The leading potato producing states in India are Uttar Pradesh, 15323 tonnes with sharing (30.53%), followed by West Bengal, 11000 tonnes with sharing (21.92%), Bihar, 8154 tonnes with sharing (16.25 %) and Gujarat, 3707 tonnes with sharing (7.39 %) which constitute about 76.10 % of the total domestic potato production (Anonymous, 2018-19).

The main reasons of low productivity are potato suffers from a number of diseases caused like, early blight, late blight, common scab, leaf spot, dry rot, charcoal rot, black scurf, soft rot, leaf roll etc. Among them, common scab *Streptomyces scabies* (Thaxter) Waksman & Henrici was found as major tuber / soil borne diseases that affect both quality and quantity of tubers (Rauf *et al.,* 2007). The causal agent of common scab was first described by Thaxter (1891) as *Oöspora scabies*, a melanin-producing actinomycete bearing grey spores in spiral spore chains. The name was later changed to *Actinomyces scabies* by Güssow (1914), followed by *S. scabies* (Waksman & Henrici) in 1948. The pathogen producing a phytotoxin, known as thaxtomin is a pathogenicity determinant involved in symptom development of common scab pathogens (King *et al.,* 1989). *Streptomyces scabies* is the most common species and has been reported worldwide (Loria *et al.,* 1997; Miyajima *et al.,* 1998).

The management of the disease can be done through cultural, biological, chemical and use of resistant variety and there is no doubt that the chemical are the best method for management of the disease.

Presently, bactericide is the mainstay in the control of common scab given the fact there has not been any complete resistant variety in the market for farmers to use (Kemmitt, 2002). However, continuous use of synthetic chemical are not economical and eco-friendly.

A control practice that has shown promise for plant disease management is the use of systemically induced plant resistance. The plant possesses a range of defences that can be activated to protect it from diseases.

This defence response, termed systemic acquired resistance, can be localized at the site of application of an inducer and can also be transmitted systemically to other plant tissues of the same plant (Kessmann *et al.,* 1994).

Hence, the topic entitled “Induced systemic resistance in potato against common scab (*Streptomyces scabies* (Thaxter) Waksman & Henrici) through Inorganic chemicals as inducers” has been undertaken in the present investigation.

## Materials and Methods

### Effect of tuber treatment with inorganic chemicals as inducers on disease index and tuber yield of potato plants.

Truely labeled potato seed tubers of variety '*Kufri Badshah*' were collected from Vegetable Research Farm, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur to conduct the experiment. Two seed tubers were placed in each jar containing inorganic chemicals solution of each inducer for 4-5 hours. It was then removes from the jar and shaded dry and used for sowing in pots. The treated tubers seeds were planted in 30 cm pots which were previously filled up with a mixture of sterilized sandy loam soil and Mushroom compost in the ratio of 2:1. Two treated tubers were placed in each pot and watered as per need based. Three replications were kept for each treatment. In one experiment, untreated tubers were sown served as control-1 (Healthy) and treated with *Streptomyces scabies* suspension served as control-2 (infected).

### Observations Recorded

### Measurement of disease index

The treatments of Inorganic Chemicals *viz.* Salicylic acid, $CaCl_2$, $H_2O_2$, Boric acid, DPHP, ferric chloride, IAA and Copper chloride etc. will be applied on the foliage as pre inoculation with the pathogen. Disease index will be recorded (DI) will be calculated for each treatments. Disease was measured on a scale of 0-5 where 0 = healthy; 1 = up to 10; 2 = >10 to 25; 3 = >25 to 50; 4 = >50 to 75 and 5 = > 75 per cent tuber surface affected by scab.

Disease index (DI) was calculated by using formula described by Jeswani and Sharma (1990) as:

$$\text{Disease index} = \frac{\left(\begin{matrix}\text{No. of} \\ \text{tubers}\end{matrix} \times \begin{matrix}\text{their disease intensity} \\ \text{grade}\end{matrix}\right)}{\text{Total number of tuber}} \times \frac{100}{\text{Max disease Score}}$$

### Effect of inorganic chemicals as inducer on tuber yield of potato

To explore the possible effect of inducers on tuber yield was observed and data were taken on the weight of total number of large, medium and small tubers per treatment. Potato was categorized as large tuber>50gm, medium size of tuber 25- 49.5gm and small size of tuber <25gm. Then yield of crop was calculated by taking weight of all tubers.

## Results and Discussion

The effect of tuber treatment and foliar spray with inorganic chemicals as inducers significantly reduced disease index of common scab of potato as compared to control-1 (Healthy) and control-2 (Diseased) in wire house condition data presented in (Table-1). Among the treatments, minimum disease index with 4.45 % were recorded in case of both tuber treatment and foliar spray with salicylic acid as inducer followed by calcium chloride as 4.87 % and boric acid as 5.35% against 9.52 % control-1 and 11.71 % control-2 after harvesting, respectively during 2017-18. The similar trend of observations have also been reported during 2018-19. The minimum with 4.38, % disease index was recorded in case of both tuber treatment and foliar spray with salicylic acid against 9.47 % in case control-1 (Healthy) and 11.62 % Control-2 (Diseased) after harvesting. The calcium chloride treated plant showing 4.67% disease index, representing second lowest among treatments. From the table, it is cleared that among all inorganic chemicals, copper chloride tested plant found least effective in minimizing disease index of common scab, representing 7.29 % in 2017-18 and 7. 18 % in 2018-19 but are superior over control. Singh

and Chaudhari (2012) reported that the Disease incidence was reduced by 81.22 % and severity index by 90.17 %. In case of common scab, tuber treatment with 3 per cent boric acid followed by *B. subtilis* tuber treatment @ 2.5g/kg recorded the lowest disease incidence (31.62%) and index (1.76). (Somani, 2009) have shown its activity at 3 per cent. Garlic 4 per cent extract has given 9.41 % of common scab over check. Biswas *et al.,* (2012) also reported that pre-foliar spray with Indole acetic acid, metalaxyl, di potassium hydrogen orthophosphate, hydrogen peroxide, calcium chloride, salicylic acid and ferric chloride as inducers provided induced resistance in plant against *F. oxysporum.* f. sp. *lycopersici*, resulting decline in the disease incidence from 90.96 to 9.30% after 15 days of pathogen inoculation.

The minimum disease incidence (9.30%) was reported from calcium chloride treated plants. Hamdi *et al.,* (2015) also found that the treatment of potato plants with calcium chloride (CaCl2) reduced the spread of early blight disease by 64.2 % and increased tuber productivity by 50 %. Yogesh *et al.,* (2015) reported that the minimum disease severity of early blight of tomato with 8.56% was found in case of soil application of FYM + seed treatment with bio formulation of *T. harzianum* + foliar spray of Mancozeb. Morajdhwaj *et al.,* (2016) found that disease severity of late blight was come down from 96.00 to 7.82 per cent due to soil application of FYM and mustard cake + tuber treatment with *T. viride* + foliar spray with *T. viride*. Rajik, *et al.,* (2011) reported that the total population of soil borne microflora was also affected by organic soil amendments. Organic amendments reduced the effect of tuber infection.

The minimum infection per cent of common scab and black scurf (6.38% and 11.88%) and minimum rotting per cent of tuber (2.57%) were found in case of incorporation of crop residue in soil along with tuber treatment with bio-fertilizer (Azotobacter + Phosphobacteria). Rahman, *et al.,* (2018) found that the application of controller, Impose and Roxyl Plus at 3.0g/l to control common scab significantly decreased the disease. (Yang *et al.,* 2011) observed that the scab index was decreased from 40.1 to 28.0 and 22.7 for controller, and a greater decrease was recorded for Impose and Roxyl plus either at 3.0 and 4.0 g/l.

Yield is important parameter for crop production. Increase or decreases of the yield determine the profit or loss of any cultivars. Yield parameter depends on number of large or medium size of tubers. During the course of study, effect of tubers treatment and foliar spray with inorganic chemical as inducers on tuber size and yield was studied after harvesting. The maximum number of medium size tuber was also obtained in Salicylic acid and hydrogen peroxide treated plant, representing 4 tubers with total weight of 138.40 g and 125.55 per plant respectively followed by Calcium chloride, boric acid and di-potassium dihydrogen phosphate treated plant, representing 3 tubers for each treatment with the total weight of 121.15, 114.45 and 122.40 g, respectively.

Regarding small size tubers, themaximum number of tuber were found in Indol acetic acid treated plant, representing the 16 tubers. As per yield is concerned, the highest yield (446.85 g per plant) was recorded from salicylic acid treated plant which is 74.21 and 83.26 increase over control-1 and control-2 in year 2017-18. Similar trend of observations were also found during 2018-19 (Fig.-4-5). Stromberg and Brishammar (1991) had also been found that treatment of potato plants with phosphate provided induced resistance against late blight disease and tended to positively influence yield and dry matter.

**Table.1** Effect of inorganic chemicals as inducer on disease index common scab of potato under Wire house condition during 2017-18 and 2018-19

| Name of inorganic chemicals | Concentration of inorganic chemicals | Disease index | | Per cent disease index control over control-1 | | Per cent disease index control over control-2 | |
|---|---|---|---|---|---|---|---|
| | | 2017-18 | 2018-19 | 2017-18 | 2018-19 | 2017-18 | 2018-19 |
| **SA** | 10mM | 4.45 | 4.38 | 53.05 | 53.75 | 61.99 | 62.31 |
| **$CaCl_2$** | 10 mM | 4.87 | 4.76 | 48.84 | 49.74 | 58.41 | 59.04 |
| **$H_2O_2$** | 10ppm | 5.72 | 5.64 | 39.92 | 40.44 | 51.15 | 51.46 |
| **Boric acid** | 0.1 % | 5.35 | 5.29 | 43.80 | 44.14 | 54.31 | 54.48 |
| **DPHP** | 0.2 % | 6.97 | 6.85 | 26.79 | 28.19 | 40.48 | 41.05 |
| **$FeCl_3$** | 5mM | 6.54 | 6.42 | 31.30 | 32.21 | 44.15 | 44.75 |
| **IAA** | 1 % | 6.15 | 6.06 | 35.40 | 36.01 | 47.48 | 47.85 |
| **$CuCl_2$** | 10mM | 7.29 | 7.18 | 23.42 | 24.18 | 37.75 | 38.21 |
| **Control-1** | - | 9.52 | 9.47 | - | - | 18.70 | 18.50 |
| **Control-2** | - | 11.71 | 11.62 | -23.00 | -22.70 | - | - |
| **SEm±** | - | 0.12 | 0.09 | - | - | - | - |
| **CD at 5 %** | - | 0.37 | 0.25 | - | - | - | - |

**Table.2** Effect of inorganic chemical as inducers on tuber size and yield of potato under Wire house condition during 2017-18.

| Name of inducers | Concentration of inducers | Large (>50g) | | Medium (25-50 g) | | Small < 25 g | | Total Yield (/pot) | % Increase Yield Over Control-1 | % Increase Yield Over Control-2 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Total Number of Tuber | Weight (g) | Total Number of Tuber | Weight (g) | Total Number of Tuber | Weight (g) | | | |
| **SA** | 10 mM | 4 | 245.50 | 3 | 103.80 | 10 | 116.10 | 465.40 | 74.21 | 83.26 |
| **$CaCl_2$** | 10mM | 3 | 168.25 | 4 | 135.15 | 12 | 140.25 | 443.65 | 66.07 | 74.70 |
| **HP** | 10 ppm | 2 | 136.60 | 2 | 81.30 | 15 | 190.20 | 408.10 | 52.76 | 60.70 |
| **Boric acid** | 0.1% | 3 | 164.15 | 3 | 88.65 | 14 | 168.55 | 421.35 | 57.72 | 65.92 |
| **DPHP** | 0.2% | 1 | 59.30 | 2 | 72.40 | 15 | 173.20 | 304.90 | 14.13 | 20.06 |
| **$FeCl_3$** | 5mM | 1 | 64.20 | 2 | 79.30 | 17 | 184.35 | 327.85 | 22.72 | 29.10 |
| **IAA** | 1% | 2 | 104.60 | 2 | 74.10 | 14 | 165.45 | 344.15 | 28.82 | 35.52 |
| **$CuCl_2$** | 10mM | 1 | 52.45 | 2 | 65.40 | 16 | 167.35 | 285.20 | 6.76 | 12.31 |
| **Control-1** | - | 0 | 0.00 | 2 | 63.50 | 20 | 203.65 | 267.15 | - | 5.19 |
| **Control-2** | - | 0 | 0.00 | 2 | 59.25 | 19 | 194.70 | 253.95 | -4.94 | - |
| **SEm±** | - | 0.03 | 2.00 | 0.05 | 1.38 | 0.27 | 2.67 | 5.02 | - | - |
| **CD at 5 %** | - | 0.10 | 5.94 | 0.14 | 4.11 | 0.84 | 7.95 | 14.91 | - | - |

**Table.3** Effect of inorganic chemical as inducers on tuber size and yield of potato under Wire house condition during 2018-19

| Name of inducers | Concentration of inducers | Large (>50g) | | Medium (25-49.5g) | | Small < 25 g | | Total Yield (g/plant/pot) | % Increase Yield Over Control-1 | % Increase Yield Over Control-2 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Total Number of Tuber | Weight | Total Number of Tuber | Weight | Total Number of Tuber | Weight | | | |
| **SA** | 10mM | 3 | 188.15 | 4 | 138.40 | 11 | 146.10 | 472.65 | 74.31 | 83.76 |
| **$CaCl_2$** | 10 mM | 3 | 176.25 | 3 | 121.15 | 12 | 149.45 | 446.85 | 64.79 | 73.73 |
| **$H_2O_2$** | 10ppm | 2 | 125.55 | 4 | 140.25 | 10 | 148.05 | 413.85 | 52.62 | 60.90 |
| **Boric acid** | 0.1 % | 3 | 158.25 | 3 | 114.45 | 15 | 152.55 | 425.25 | 56.83 | 65.33 |
| **DPHP** | 0.2 % | 1 | 57.85 | 3 | 122.40 | 13 | 130.70 | 310.95 | 14.67 | 20.89 |
| **$FeCl_3$** | 5mM | 1 | 62.30 | 2 | 94.30 | 15 | 176.80 | 333.40 | 22.95 | 29.62 |
| **IAA** | 1 % | 2 | 110.45 | 2 | 76.20 | 16 | 172.85 | 359.50 | 32.58 | 39.77 |
| **$CuCl_2$** | 10mM | 1 | 55.05 | 2 | 68.90 | 14 | 168.65 | 292.60 | 7.91 | 13.76 |
| **Control-1** | - | 0 | 0.00 | 2 | 73.45 | 18 | 197.70 | 271.15 | - | 5.42 |
| **Control-2** | - | 0 | 0.00 | 2 | 64.25 | 15 | 192.95 | 257.20 | -5.14 | - |
| **SEm±** | | 0.02 | 1.75 | 0.04 | 1.48 | 0.21 | 2.07 | 5.85 | | |
| **CD at 5 %** | | 0.07 | 5.21 | 0.12 | 4.39 | 0.62 | 6.16 | 17.39 | | |

Abd-El-Kareem (1998) also found that spraying cucumber plants with $K_2HPO_4$ (100mM) provided induced resistance against downy and powdery mildews and increased fruit yield per plant under commercial greenhouse conditions. Abd-El-Kareem *et al.,* (2001) also reported that, treated potato plants with chitosan provided induced resistance against late and early blight diseases and increased tuber yield under field conditions. Pre-harvest application with CaCl2 and chitosan was effective in minimizing weight loss and decay, as well as in maintaining maximum firmness and lengthening shelf life of 'Early Swelling' peach (Gayed *et al.,* 2017). Ravindra *et al.,* (2015) found that the yield of tomato crop significantly increase by the combine application of seed treatment with *T.harzianum* + soil application of neem cake powder + foliar spray of carbendazim.

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