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Dry rot of potato (c.o. *Fusarium oxysporum* Schlecht) and its management by essential oils

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In India, potato as a co-staple vegetable is difficult to preserve for more than eight months under cold storage condition, and succumbed to various diseases including dry rot (*Fusarium oxysporum*), which is more common. Farmer's grown cured potato tubers were treated with five different essential oils like gaultheria, citronella, almond, camphor and thyme as pre- and post inoculation treatment in order to assess their effectiveness against *Fusarium oxysporum*. All five essential oils are effective but tissue discolouration due to oil touching the tubers was noticed. Camphor oil @ 0.6 ml/kg of potato tubers was found to be best effective. Improvement in the methodology of treatment has been suggested.

Key words: Potato, Dry rot, *Fusarium oxysporum*, essential oils, management

INTRODUCTION

The potato (*Solanum tuberosum* L.), as a season bound, starchy tuberous crop of Solanaceae family, is cultivated in different countries of the world and used mostly as vegetables. Potato is nutritionally superior as compared to other vegetables and for the future it is recognized as a bank for food security and economic development for Latin America, Africa and Asia. In this sub-continent too, particularly in India, potato has emerged as fourth most important food crop after rice, wheat and maize. According to global production India occupied the second position, preceded by Peoples Republic of China. The consumption pattern of potao between developing and developed nations, the steady supply of potato in the market, spiralling price and its impact on both regional as well as national economy are known (CPRI 2007). In India, the state of West Bengal becomes the second largest producer (around 80-115 lakh tonnes) of potato after Uttar Pradesh, yet it continues to be also a surplus state in potato production for last three decades. The state of West Bengal has second largest number of cold storages after UP and production-market price-postharvest crop loss are all closely linked and remains crucial for the economy of southern parts of the state. In potato postharvest biotic diseases are more in numbers and among them fungal diseases outnumbered bacterial infections. The dry rot (*Fusarium* spp.) is long known in India and still remains important as it results in loss of 5-20% (Toppo, 2008). This disease has frequently encountered both in the cold store produce and in the market.

Dasgupta and Mandal (1989) have previously collated the control of this disease and pointed out

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that thiabendazole, procymidone, vitavax + captan are effective but now considered to be unacceptable to the elite current consumers who have the preferences to residue free organically treated produce. Among the alternative methods of management the use of essential oils has been found to be promising as many of them are both sprout and pathogen inhibitor. Most of the essential oils are known to have low toxicities to humans and the major components are often used for their particular flavour and fragrance. Sprouting is one of the major problems of spoilage of potato in marketing. The knowledge on properties of essential oils as pathogenic inhibitor is relatively new. Essential oils of caraway, cassia, cumin, dill, and spearmint were shown to be effective in limiting the radial growth of the tuber pathogens *Fusarium solani* var.*coeruleum*, *Fusarium sulphureum*, *Phoma exigua* var. *foveata* and *Helminthosporium solani*, when applied at concentration of 160 ppm. Both volatile compounds cineole and menthol can inhibit the growth of *Fusarium sambucinum*. A treatment of 1 to 3 mmol of carvone can inhibit the growth of plant-pathogenic fungi like *F. solani* and *F. sulphureum*. The bioconversion of essential oil components were reported in studies conducted on strawberries and potatoes. No studies have ever been made in India with essential oils in postharvest systems and in view of this the present investigation was undertaken.

MATERIALS AND METHODS

Fusarium oxysporum pre-inoculation treatments

Fresh farmers grown potato tubers were washed with tap water to remove dust and crop debris. Potato tubers were surface sterilized with 0.1% $HgCl_2$ solution followed by three washings with sterilized distilled water. Five essential oils comprising five treatments each with three replications were used. Each replication consists of eight tubers. A small wound was made with the help of sterilized scalpel on the surface sterilized tubers. A small absorbent cotton swab containing 0.5 ml of individual essential oil was placed within polybags containing the tubers. Cotton swabs soaked with oil in uninoculated potato serves as control. The pathogen of equal diameter (about 4 mm) was inoculated aseptically after 48 hrs of treatment of tubers in room temperature with fresh full growth of 36 - 48 hrs old *Fusarium oxysporum* culture. A piece of cotton swab soaked in sterile water was placed for 48 hrs within poly bags in order to ensure high relative humidity much essential for successful infection. Polybags were perforated in order to maintain normal atmospheric condition and to ensure adequate supply of oxygen to prevent bacterial soft rot by incipient bacterial infections. The entire experimental tuber materials were then packed in leno gunnies stored in the Kalimata Cold Storage, Naranghati, Sainthia. Bags were suitably tagged with permanent marker. A five point severity rating scale (0-4) was used to assess the impact of the essential oils on dry rot. 0 = No infection; 1 = Slight growth initiated around injury only; 2 = Moderate growth around injury site; 3 = Moderate growth within injury and also slight floccular growth at surface; 4 = Extensive luxuriant growth within injury and on surface along with decaying of tuber around injury site.

Fusarium oxysporum post-inoculation treatments

Sterilization of tubers, number of tubers per replication, age of fungal culture, amount of inoculum, method of inoculation, maintenance of high relative humidity, tagging, severity rating scale for assessment of effectiveness etc. were similar as mentioned above. These inoculated potato tubers were allowed to incubate for 36 hrs in room temperature to allow successful infection at the wound site. The tubers were packed after 50 hrs of treatment and stored in the Kalimata cold storage.

RESULTS AND DISCUSSION

Efficacy of essential oils as pre- inoculation treatments

The Dry rot is (c.o. *Fusarium* spp.) known as most serious disease all over the world. These essential oils are volatile and systemic and therefore they can be utilized. Generally, pre-inoculation treatment is used to check the future progress of pathogens through their residual effect or have the impact on modulation of resistance. The close examination of Table 1 reflects that there were wide variations in severity among the tubers examined for the concerned experiment. Such variation is possible because of inherent variations in quality of tubers in terms of maturity, reaching of volatiles in the wound sites and may also be due to unequal wound depth, since mechanical methods of

Table 1 : Efficacy of different essential oils as pre- inoculation treatments on dry rot of potato (*Fusarium oxysporum*)

Essential oil Treatments	Severity Range	After 90 days of cold storage		
		Av. disease index %	Change in tuber colour	Other pathogens
T1 Gaultheria	0-3	8.33	40% tubers become brownish	Bacteria, *Penicillum*
T2 Citronella	0-2	7.5	70% tuber retains good colour	Bacteria
T3 Almond	0-2	5.83	78% tuber retains good colour	Bacteria, *Penicillum*
T4 Camphor	0-3	5.0	Tubers colour slightly dull	*Penicillum,* Bacteria
T5Thyme	0-2	13.33	50% tubers only good	Bacteria, *Penicillum*
T6 Control	0-4	35.83	Only 25% retain colour	*Penicillum* and bacteria

Table 2 : Efficacy of different essential oils as post- inoculation treatments on dry rot of potato (*Fusarium oxysporum*)

Essential oil Treatments	Severity Range	Av. disease index %	Change in tuber colour	Other pathogens
T1 Gaultheria	0-1	15	63% tuber retained good colour	Bacteria and *Penicillum*
T2 Citronella	0-4	20	Colour became brownish	Bacteria
T3 Almond	0-2	12.5	Colour became brownish in 2 5% tubers	Bacteria and *Penicillum*
T4 Camphor	0-2	4.17	100% tuber retained good colour	-
T5Thyme	0-3	17.5	50%tuber retained good colour and 50% brownish	Bacteria
T6 Control	0-4	35.8	Only 25% retained colour	*Penicillum* and bacteria

wounding was followed. Improvement in this direction is called for and computerised system may be developed with assistance from postharvest engineers. It can be further noted that all the treatments with essential oils tested were effective but camphor oil (0.6 ml/kg) was the best followed by citronella oil and almond oil. In the control treatment maximum disease index was 35.83 per cent after 90 days of storage which may further enhance subsequently if stored long with reduction in hosts own resistance. None of the treatments were able to check the incipient bacterial infection and *Penicillium* contamination takes place in the cold storage. Pathogenic spectra among treatments also differed. The change in colour of tubers was inconsistent among different tubers and tubers with direct contact with essential oil became blackish and therefore improvement in the delivery system is essential. The retention of tuber colour was highest in almond oil treatment.

Efficacy of essential oils as post- inoculation treatments

The objectives of post-inoculation treatment were to wipe out pre -existing infections and /or incipient as well as latent infections which develop after harvest or chance infections of opportunistic pathogens through wounds, lenticels at post-harvest phase. The use of severity rating scale is provided above and data of this experiment are presented in Table 2. The close examination of the Table 2 revealed that all the essential oils were effective against the inoculated pathogen up to a holding period of 90 days. Camphor oil was found to be best effective as average infection index was below 5%. The colour of all the tubers in camphor treatment was best among all treatments. Other three oils i.e., almond, gaultheria and thyme were almost equally effective as disease index per cent was 12.5-17.5. The temperature maintenance in the cold storage was also good and none of the tubers including control no initiation of sprouting was recorded suggesting future commercial exploitation of essential oils as anti-sprout substance. Clove oil @ 160 ppm was found as effective sprout inhibitor as well as inhibitor of *Fusarium solani* and *Fusarium sulphureum* under *in vitro* condition and this corroborates also our finding.There was variation in the spectra of other pathogens. Bacterial pathogens perhaps have invaded through lenticels during washing. There was wide gap in variation of disease rating indicate that the growing condition in the plot was not uniform and perhaps fertilizer dose was not uniform due to poor land levelling. In such type of innovative experiment uniform quality of tuber grown under strict supervision is essential. Certain areas of camphor treated tubers were also depressed but it may not be due to treatment as not noticed when sent to cold storage. The examination of Table 1 and Table 2 clearly indicate that the camphor oil either as pre- and post-inoculation treatment was almost equally effective perhaps due to good penetration of vapour within the host tissues. Further experiments with different dosages and a pilot study with larger volumes of tubers are required for commercial exploitation. The cost –benefit ratio may be worked out. Care should also be taken that oil does not touch the tuber and cotton soaked with oil be placed within the perforated small polypouches for commercial trial in future.

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