

# INTEGRATED DISEASE MANAGEMENT OF PURPLE BLOTCH DISEASE OF ONION

B. S. CHETHANA\*<sup>1</sup>, G. GANESHAN, S. R. ARCHANA AND K. BELLISHREE<sup>2</sup>

Division of Plant Pathology,

Indian Institute of Horticulture Research, Bangalore-89, Karnataka, INDIA

<sup>1</sup>Zonal Agricultural Research Station (AICRP on Rice),

Vishweshwaraiah Channel Farm, Mandya - 571 405, Karnataka, INDIA

<sup>2</sup>Division of Plant Pathology, Indian Institute of Horticulture Research, Bangalore - 89, Karnataka, INDIA

e-mail: chethanabs.pathology@gmail.com

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\*Corresponding  
author

## ABSTRACT

Purple blotch caused by *Alternaria porri* (Ellis) Ciff. is the most destructive disease commonly prevailing in onion growing areas of the world. Field experiments were conducted to evaluate the efficacy of sequential and solo application of bioagents, botanicals and fungicides as foliar spray against purple blotch disease of onion for two consecutive seasons (2009-2010 and 2010-2011). Among the six different sequential treatments, mancozeb followed by *Trichoderma harzianum* and pongamia oil (Sq1) was found effective and recorded least mean disease intensity of 25.54% and highest bulb yield of 33.01t/ha. Mancozeb (Mz-Mz-Mz) was the most effective fungicide with least mean disease intensity of 22.87% and yield of 32.09t/ha. Among the bioagents and botanicals *T. harzianum* and garlic extract were effective recording mean disease intensity of 28.62% and 27.34% and an yield of 29.70 t/ha and 33.03t/ha. The highest and comparatively equal cost benefit ratio was obtained in mancozeb (1:10:18) and Sq1 (mancozeb-*Trichoderma harzianum*- pongamia oil). The sequential application of Mancozeb-*T. harzianum*-Pongamia oil (Sq1) is the best IDM package reported for the first time to obtain residue free produce. By adopting IDM package (Sq1) the usage of fungicides could be minimized to an extent of 66% and can be an economically viable substitute for three sprays of mancozeb (Mz-Mz-Mz).

## INTRODUCTION

Onion (*Allium cepa* L.) is a spice cum vegetable crop of global importance. It is native to south western Asia and is widely cultivated under different agro-climatic conditions in more than 175 countries. Onion is susceptible to numerous foliar, bulb and root pathogens that reduce yield and quality. Irrespective of the varieties, the spectrum of diseases that affect the onion remains the same. There are nearly about 57 diseases caused by fungi, bacteria, viruses and nematodes reported across the globe. Among the major fungal diseases, purple blotch caused by *Alternaria porri* (Ellis) Cif. is the most destructive disease commonly prevailing in almost all onion growing pockets except in very cool production areas of the world (Cramer, 2000). Purple blotch of onion caused by *Alternaria porri* is one of the most serious diseases in India (Tripathi *et al.*, 2008; Ramjegathesh *et al.*, 2011). The disease causes extensive damage to bulbs as well as a seed crop. The disease become epidemic under favourable weather conditions of high relative humidity (80-90%) and optimum temperature (24 ± 10°C) (Yadav *et al.*, 2013). The yield losses of bulb and seed crop in India due to this disease under favourable conditions are upto 97% (Gupta and Pathak, 1998; Lakra, 1999). Over two decades the disease has become menace to onion growers in India. There are no resistant varieties available for cultivation in India. Thus farmers are left with no choice other than using pesticides to protect the

crop. Although there are several effective fungicides available the unwise and indiscriminate application of pesticides results in the accumulation of residues in the produce and in the environment which leads to health and environment hazards and builds up resistance in the pathogen population. So management of disease through chemicals is not always effective and desirable (Behera *et al.*, 2013). Thus in recent years due to aforementioned reasons several workers have initiated research on developing integrated disease management (Shahnaz *et al.*, 2013; Savitha *et al.*, 2014). The present study was undertaken to develop integrated disease management package for purple blotch disease of onion to minimize the usage of fungicide and to obtain residue free produce.

## MATERIALS AND METHODS

The field trials were carried out during Kharif 2009-2010 and 2010-2011 at Indian Institute of Horticultural Research Hesaraghatta, Bangalore (13°58' N 78°E 890M). The experiment was laid out in randomized block design with fifteen treatments and three replications. Onion seeds (cv. Arka Niketan) were directly sown in 15cm wide rows in plots of net plot size of 2x1m. Thirty days after sowing; thinning of seedlings was done to maintain a spacing of 10cm between plants and 15 cm between rows. The fertilizer application *i.e.* FYM (25 t/ha) and NPK (Urea: 65 kg, single Super phosphate: 366 kg, murate of Potash: 46.5kg) and other agronomic

practices were followed as per recommendation. The field was kept free from weeds by frequent hand weeding during the early stages of the crop. The most effective fungicide, botanical and bioagent evaluated under *in vitro* were further evaluated individually and in combination under field conditions. The fungicides, plant product and bioagent were selected based on experimental results under field condition (Chethana *et al.*, 2013).

A total of six different combination treatments involving fungicide, bioagent and botanical were evaluated for two consecutive years for the management of purple blotch of onion. Each of the IDM sequence was compared with its individual component. An untreated control was maintained by only giving water spray. Different sequences of fungicides, bioagent and botanicals applied are listed below.

Sq1→Mancozeb- *T. Harzianum*-Pongamia oil

Sq2→Propineb- *T. harzianum*-pongamia oil

Sq3→COC- *T. harzianum*- pongamia oil

Sq4→Mancozeb- *Chaetomium* sp. - Garlic extract

Sq5→Propineb- *Chaetomium* sp. - Garlic extract

Sq6→COC- *Chaetomium* sp. - Garlic extract.

The foliar application was started immediately after the appearance of disease symptoms. A total of three sprays were carried out at ten days intervals. A total volume of 500 litres spray solution was used per hectare. The observations on disease intensity were recorded before each spray using 0-5 scale of (Sharma, 1986). The details of 0-5 scale is as follows 0 - No disease symptom; 1 - A few spots towards tip covering 10 percent leaf area.; 2 - Several purplish brown patches covering upto 20 percent of leaf area.; 3 - Several patches with paler outer zone covering upto 40 percent leaf area; 4 - Leaf streaks covering upto 75 percent leaf area or breakingof the leaves from center and 5 - Complete drying of the leaves or breaking of leaves fromcenter

Percent disease index (PDI) was calculated by using the following formula Wheeler (1969).

$$PDI = \frac{\text{Total sum of all the ratings}}{\text{Maximum disease rating}} \times \frac{100}{\text{Number of observation taken}}$$

#### AUDPC

(area under disease progress curve) was calculated according to the equation of Campbell and Madden (1990).

$$AUDPC = \sum \frac{1}{2} (S_i + S_{i+1}) \times (t_{i+1} - t_i)$$

$S_i$  = Disease intensity at time  $t_i$

$S_{i+1}$  = Disease intensity at time  $t_{i+1}$

$t_i$  = Time when disease intensity was  $S_i$

$t_{i+1}$  = Time when intensity  $S_{i+1}$

#### Preparation of botanicals for spraying

Garlic extract was prepared by grinding required quantity of cloves in a mixer (w/v) (1:1) and strained through a double layered muslin cloth before the spray. The turmeric powder was mixed with required quantity of water stirred well with constant stirring for 30 minutes and allowed to settle for 60

minutes. The supernatant was used for spraying. The commercial *pongamia* oil emulsified with sandovit @ 20% was used spraying.

#### Preparation of fungal bioagent formulation

The talc based formulation of *T. harzianum* and *Chaetomium* sp. was prepared (Vidhyasekaran and Muthamilan,1995). One kg of talc powder and 10 grams of carboxy methyl cellulose powder (CMC) was mixed well and autoclaved in polypropylene cover for 30 min. Fungal bioagents were grown in potato dextrose broth (PDB) in 250ml Erlenmeyer flasks for 10 days at room temperature. The mycelial mat along with broth was added to autoclaved talc + CMC powder @20% and mixed thoroughly in a blender and dried overnight to attain moisture content of approximately 11%. After drying, the mixture was packed in polythene bag, sealed and stored at room temperature for further use (Bhat *et al.*, 2009). The population of spores at the time of application in the formulation was assessed and maintained around 3 or 4  $\times 10^7$  cfu/g.

#### Harvesting and computing yield records

The crop was harvested when the leaves turned yellow and the top fall occurred. Bulbs harvested from each plot were, weighed and expressed as kg per plot. On the basis of yield per plot, the total bulb yield was computed and expressed in tonnes per hectare.

#### Benefit: cost ratio (BCR)

The economics of treatments was worked out by considering the prevailing rates of inputs, produce labour charges and expressed as incremental cost benefit ratio.

$$B. \text{ Cratio} = \frac{\text{Additional benefits of the produce from each treatment}}{\text{Additional cost of each treatment}}$$

The data on yield and PDI was subjected to statistical analysis following the standard procedures (Panse and Sukhatme, 1967) to obtain significant difference between treatments by using F test (Gomez and Gomez, 1984). The percentage values were transformed to arcsine percentage and numbers to square root transformation and subjected to statistical analysis.

## RESULTS AND DISCUSSION

In the first season (Kharif, 2009-2010) sequential application of Mancozeb-*Chaetomium* sp.- Garlic extract (Sq4) was significantly effective in reducing the disease by recording a PDI of 22.93 and a yield of 36.05t/ha (Table 1). Sq1 (Mancozeb- *T. harzianum* *pongamia* oil) and Sq5 (Propineb-*Chaetomium* sp. garlic extract) were the next best sequence found effective in reducing the disease intensity by recording a PDI of 25.80 and 25.89 and yield of 34.88t/ha and 33.22t/ha respectively. The sequence Sq2 (Propineb-*T.harzianum*-*pongamia* oil) was less effective by recording a PDI of 34.63 and yield of 27.06 t/ha. Solo applications (three times) of mancozeb, propineb, chlorothalonil, copper oxychloride and garlic extract were significantly effective in reducing the disease intensity by recording a PDI of 19.08, 21.10, 20.91, 21.73 and 21.52 and an yield of 33.17, 31.00, 31.41, 31.83 and

**Table 1: Field evaluation of sequential application of bioagent, botanicals and fungicides in the management of purple blotch disease of onion (I season)**

Treatments	PDI	AUDPC	% decrease in disease over control	Healthy bulbYield (t/ha)	% increase in healthy yield over control
Sq1(Mancozeb- <i>T.harzianum</i> -pongamia oil)	25.80(30.46) <sup>b</sup>	723.61	27.45	34.88 <sup>ab</sup>	41.39
Sq2(Propineb- <i>T.harzianum</i> -pongamia oil)	34.63(36.03) <sup>c</sup>	1010.00	2.62	27.06 <sup>a</sup>	9.69
Sq3(copper oxychloride- <i>T.harzianum</i> -pongamia oil)	30.22(33.24)	885.00	15.01	26.17 <sup>a</sup>	6.07
Sq4(Mancozeb- <i>Chaetomium</i> sp. -garlic extract)	22.93(28.59) <sup>a</sup>	608.22	35.52	36.05 <sup>ab</sup>	46.13
Sq5(Propineb- <i>Chaetomium</i> sp. -garlic extract)	25.89(30.53) <sup>b</sup>	730.00	27.20	33.22 <sup>b</sup>	34.67
Sq6(Copper oxychloride - <i>Chaetomium</i> sp. -garlic extract)	28.17(32.08) <sup>b</sup>	807.50	20.77	29.67 <sup>b</sup>	20.28
Mancozeb @ 0.25%	19.08(25.84) <sup>a</sup>	510.28	46.35	33.17 <sup>b</sup>	34.47
Propineb@ 0.25%	21.10(27.35) <sup>a</sup>	587.72	40.68	31.00 <sup>b</sup>	25.66
Copper oxychloride @0.25%	21.73(27.76) <sup>a</sup>	562.67	38.88	31.83 <sup>b</sup>	29.01
Chlorothalonil@0.25%	20.91(27.20) <sup>a</sup>	580.11	41.21	31.41 <sup>b</sup>	27.34
<i>Trichoderma harzianum</i> @2%	26.99(31.34) <sup>b</sup>	758.44	24.10	30.27 <sup>b</sup>	22.70
<i>Chaetomium</i> sp. @2%	26.32(30.85) <sup>b</sup>	733.89	25.99	28.48 <sup>a</sup>	15.46
Pongamia oil@2%	26.67(31.05) <sup>b</sup>	722.22	25.01	29.24 <sup>a</sup>	18.51
Garlic extract@10%	21.52(27.62) <sup>a</sup>	561.22	39.49	30.99 <sup>b</sup>	25.63
Control	35.56(36.63) <sup>c</sup>	1155.00		24.67 <sup>a</sup>	
S.Em ± C	2.00			2.25	
Dat 5%	4.10			4.61	

Figures in parentheses are square root transformed values, in a column, means followed by a common letter(s) are not significantly different by LSD (P=0.05)

**Table 2: Field evaluation of sequential application of bioagent, botanicals and fungicides in the management of purple blotch disease of onion (II season)**

Treatments	PDI	AUDPC	% decrease in disease over control	Healthy bulb yield (t/ha)	% increase in healthy yield over control
Sq1(Mancozeb- <i>T.harzianum</i> -pongamia oil)	25.29(30.20) <sup>a</sup>	533.7	55.41	31.87 <sup>c</sup>	40.94
Sq2(Propineb- <i>T.harzianum</i> -pongamia oil)	32.00(34.45) <sup>ab</sup>	693.3	43.57	30.03 <sup>b</sup>	32.93
Sq3(copper oxychloride- <i>T.harzianum</i> -pongamia oil)	28.42(32.20) <sup>b</sup>	589.3	49.88	31.15 <sup>c</sup>	37.89
Sq4(Mancozeb- <i>Chaetomium</i> sp.-garlic extract)	31.96(34.39) <sup>ab</sup>	670.3	43.65	31.15 <sup>c</sup>	37.88
Sq5(Propineb- <i>Chaetomium</i> sp. -garlic extract)	34.56(35.97) <sup>d</sup>	715.0	39.07	28.94 <sup>b</sup>	28.13
Sq6(Copper oxychloride- <i>Chaetomium</i> sp. -garlic extract)	31.71(34.27) <sup>ab</sup>	643.0	44.08	30.38 <sup>b</sup>	34.48
Mancozeb @0.25%	26.67(31.11) <sup>a</sup>	575.0	52.98	31.00 <sup>c</sup>	37.23
Propineb@0.25%	32.33(34.63) <sup>ab</sup>	745.0	42.98	30.55 <sup>c</sup>	35.22
Copper oxychloride @0.25%	29.89(33.09) <sup>b</sup>	680.0	47.30	26.95 <sup>b</sup>	19.29
Chlorothalonil@0.25%	35.00(36.27) <sup>d</sup>	786.0	38.28	24.05 <sup>a</sup>	6.48
<i>Trichoderma harzianum</i> @2%	30.25(32.40) <sup>b</sup>	610.0	46.61	29.14 <sup>b</sup>	28.98
<i>Chaetomium</i> sp. @2%	35.33(36.45) <sup>d</sup>	750.0	37.70	24.93 <sup>a</sup>	10.37
Pongamia oil@2%	51.27(45.69)	1246.0	9.60	24.40 <sup>a</sup>	8.01
Garlic extract@10%	33.16(35.12) <sup>ab</sup>	1188.0	41.53	35.04	55.23
Control	56.71(48.85)	1250.0		22.59 <sup>a</sup>	
S.Em ±	1.44			1.92	
CD at 5%	2.96			3.95	

Figures in parentheses are square root transformed values, in a column, means followed by a common letter(s) are not significantly different by LSD (P=0.05)

30.99t/ha respectively over untreated control. Several workers have reported the effectiveness of fungicides against purple blotch disease of onion (Sharma 1986; Gupta *et al.*, 1996; Upadhyay and Tripathi, 1995; Upamanyu and Sharma, 2007). However solo application of mancozeb was on par with sequence Sq1 and Sq4 sequences which had mancozeb as one of the component.

All the fungicides were significantly superior over sequences *i.e* Sq2, Sq3 and Sq6 and solo application of *Trichoderma harzianum*, *Chaetomium* sp. and pongamia oil. The data on area under disease progress curve (AUDPC) of first season indicate the lowest AUDPC value was recorded mancozeb (510.28) followed by garlic extract (561.22).

In the second season Sq1 (mancozeb- *Trichoderma harzianum*- pongamia oil) was the most effective treatment by

recording a PDI of 25.29 and a yield of 31.87t/ha (Table 2). The next best sequence was Sq3 (copper oxychloride - *Trichoderma harzianum*-pongamia oil) with PDI 28.42 and yield of 31.15t/ha. Several workers have reported the effectiveness of sequential application of combination treatments in the management of *Alternaria* blight of cumin, tomato, mustard and onion [Polra and Jadeja, 2011; Patel *et al.*, 2010; Prasad and Lallu; Naharet *et al.*, 2006]. Sq5 (propineb-*Chaetomium* sp. - garlic extract) was less effective in reducing the disease intensity by recording a maximum PDI of 34.56 however the yield (28.94 t/ha) was on par with other sequences. Solo application of mancozeb (PDI 26.67 and yield 31.00t/ha) was significant over all other treatments and at par with sequential treatment of Sq1 and Sq3 in reducing the disease intensity. The data of second season indicated the lowest AUDPC value in sequential treatment of mancozeb-

**Table 3: Field evaluation of sequential application of bioagent, botanicals and fungicides in the management of purple blotch disease of onion (a pooled analysis)**

Treatments	PDI	% decrease in disease over control	AUDPC	Healthy bulbYield (t/ha)	% increase in healthy yield over control	B:C ratio
Sq1(Mancozeb- <i>T.harzianum</i> -pongamia oil)	25.54 (30.33) <sup>a</sup>	44.63	628.7	33.01 <sup>c</sup>	39.72	10.18
Sq2(Propineb- <i>T.harzianum</i> -pongamia oil)	31.53 (34.14) <sup>ab</sup>	31.66	851.7	29.45 <sup>b</sup>	24.62	4.32
Sq3(copper oxychloride- <i>T.harzianum</i> -pongamia oil)	32.39(34.70) <sup>ab</sup>	29.79	737.2	30.03 <sup>b</sup>	27.07	6.59
Sq4(Mancozeb- <i>Chaetomium</i> sp. -garlic extract)	27.46(31.63) <sup>a</sup>	40.46	639.3	33.04 <sup>c</sup>	39.82	7.99
Sq5(Propineb- <i>Chaetomium</i> sp.-garlic extract)	28.92(32.52) <sup>b</sup>	37.30	722.5	32.19 <sup>c</sup>	36.21	8.66
Sq6(Copper oxychloride- <i>Chaetomium</i> sp. -garlic extract)	29.94(33.15) <sup>b</sup>	35.09	725.3	27.56 <sup>b</sup>	16.61	3.29
Mancozeb @0.25%	22.87(33.15)	50.42	542.6	32.09 <sup>c</sup>	35.79	10.19
Propineb@0.25%	26.71(31.11) <sup>a</sup>	42.09	666.4	30.77 <sup>b</sup>	30.23	5.78
Copper oxychloride @0.25%	25.81(30.53) <sup>a</sup>	44.05	621.3	29.39 <sup>b</sup>	24.36	6.59
Chlorothalonil@0.25%	27.95(31.88) <sup>a</sup>	39.40	683.1	27.73 <sup>b</sup>	17.37	4.29
<i>Trichoderma harzianum</i> @2%	28.62(31.05) <sup>b</sup>	37.96	684.2	29.70 <sup>b</sup>	25.70	5.67
<i>Chaetomium</i> sp.@2%	30.83(33.71) <sup>b</sup>	33.17	741.9	26.71 <sup>a</sup>	13.03	2.88
Pongamia oil@2%	38.97(38.59)	15.53	984.1	26.82 <sup>a</sup>	13.49	5.76
Garlic extract@10%	27.34(31.50) <sup>a</sup>	40.74	874.6	33.03 <sup>c</sup>	39.78	3.30
Control	46.13(42.76)		1202.5	23.63 <sup>a</sup>		
S.Em ±	1.19			1.68		
CD at 5%	2.45			3.46		

Figures in parentheses are square root transformed values, in a column, means followed by a common letter(s) are not significantly different by LSD (P=0.05)

*Trichoderma harzianum*- pongamia oil Sq<sub>1</sub> (533.70) followed by mancozeb (575.00).

The pooled results of two seasons revealed that the sequence Sq<sub>1</sub> (Mancozeb-*Trichoderma harzianum*- pongamia oil) was found significantly effective in reducing the disease intensity by recording a PDI of 25.54 with 44.63% disease reduction and 33.01 t/ha with 39.72% increased yield over control. Solo application of mancozeb effectively reduced the disease intensity by recording a PDI of 22.87 and an yield of 32.09 t/ha. (Table3). The results on the effectiveness of mancozeb are in line with Bhosale *et al.* (2008). Mancozeb was reported as highly effective fungicide in the management of purple blotch of onion (Chethana and Kachapur, 2010, Chethana *et al.* 2013, Shahnaz *et al.*, 2013). Solo application of mancozeb (three sprays) was most effective over all other treatments in reducing the disease and in increasing the yield which is in agreement with published reports throughout the world in the management of *Alternaria* blight in different crops (Nahar *et al.*, 2006; Prasad and Lallu, 2006). However the yield was at par with the sequence treatment Sq<sub>1</sub> and Sq<sub>4</sub>. Among the bioagents and botanical tested, *T. harzianum* and garlic extract were effective by recording PDI of 28.62 and 27.34 with a yield of yield 29.70t/ha and 33.03 t/ha. Bhosale *et al.* (2008) have reported the effectiveness of *T. viride* in the management of purple blotch disease of onion. Shahnaz *et al.*, 2013 reported *Trichoderma harzianum* is effective for the management of foliar blight of onion. The results on the effectiveness of foliar application of garlic bulb extract in the management of *Alternaria* blight are in conformity with Meena *et al.* (2004), Nashwa and Abo-Elyours (2012). The pooled data indicated that all the treatments were effective in reducing AUDPC as compared to untreated control. The lowest AUDPC value was recorded in mancozeb (542.60) followed by sequential (Sq<sub>1</sub>) treatment of Mancozeb- *Trichoderma harzianum* - Pongamia oil (628.70).

The IDM package consisted of sequential application of

fungicide, botanical and bioagent at regular intervals. Thus after fungicidal application there was a gap of 30-45 days for the final harvest of the produce by which time the fungicide will get degraded. As per the report of Girja Ganeshan and Debisharma (2007) the produce harvested after foliar application of mancozeb (0.25%), propineb (0.25%) and chlorothalonil (0.25%) with a waiting period of seven days did not show any residues (below maximum residue limit) in the produce and also in the soil.

#### Cost benefit ratio

The incremental cost benefit ratio was highest in solo application of mancozeb closely followed by sequential application of Mancozeb - *T. harzianum*-pongamia oil (Sq<sub>1</sub>). Garlic extract doesn't ensure a better cost benefit ratio in spite of higher additional net returns due to high input cost of garlic. The results comprehensively proved that sequential application of Mancozeb- *T. harzianum*-pongamiaoil (Sq<sub>1</sub>) is effective with minimum usage of fungicide and can be a substitute for repeated application of mancozeb alone. Thus managing the disease by integrating mancozeb with bioagent (*T.harzianum*) and botanical (Pongamia oil) is ecofriendly and economically viable as compared to chemical control where several applications of fungicides are needed to achieve effective control and obtaining higher yield. Thus the integrated disease management package (Sq<sub>1</sub>: Mancozeb-*T. harzianum*-Pongamia oil) could be recommended for the management of purple blotch disease of onion.

By adopting the IDM package, there is a decrease in number of fungicide applications, environmental pollution and health hazards. In addition the resistance development in pathogen population can be circumvented by introducing bioagents/ botanicals to the cropping environment, which presents the buildup of pathogen population. Thus by adopting sequential application of mancozeb-*T harzianum* -pongamia oil(Sq<sub>1</sub>), the usage of fungicides could be minimized to an extent of 66% as compared to consecutive chemical application. Since

the application of fungicide is followed by bioagent and botanical, the produce shall not pose residue problems. The sequential treatment had included first chemical application consisting of Mancozeb followed by bioagents (*T. harzianum* /*Chaetomium*) and botanicals (garlic extract or pongamia oil). In these sequences there is a clear gap of 30 days from the fungicide spray and the produce is harvested with a waiting period of seven days will not show any residues (below maximum residue limit) in the produce. According to GirijaGaneshan and Debi Sharma (2007) should be free from fungicide residues. Thus by adopting sequential treatment (Sq<sub>1</sub>: Mancozeb-*T. harzianum*-Pongamia oil) the usage of fungicides can be minimized to an extent of 66% in comparison to the consecutive chemical application and can obtain residue free produce.

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