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Perpetuation and management studies of die-back disease of almond (*Prunus amygdalus* Batsch.) caused by *Diplodia seriata* de not. From Kashmir valley

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Abstract
Diplodia seriata perpetuates through winter in the form of mycelium and pycnidia containing pycnidiospores on over-wintered infected pruned snags on orchard floor as well as un-pruned intact twigs. The maximum conidial production on infected twigs lying on orchard floor as well on un-pruned intact twigs was observed during end of May. The infected twigs of un-pruned intact twigs as well as pruned snags lying on orchard floor served as the most important over-wintering sites for *D.seriata.* The fungitoxicants tested for their efficacy against the die-back disease proved significantly effective in checking the disease. Minimum die-back intensity of 1.37 per cent was recorded in treatment T1 where copper-oxychloride 50WP (0.3%) was applied at dormant stage besides, captan + hexaconazole 75 WP (0.05%), carbendazim + mancozeb 75WP (0.25%), difenconazole 25 EC (0.03%), mancozeb 75 WP (0.3%), carbendazim 50WP (0.05%) and carbendazim + mancozeb 75WP (0.25%) applied at bud swell, bud burst, petal fall, fruit let, 20 days after and 40 days after fruit let stages, respectively. Maximum disease intensity of 9.55 per cent however, was recorded in treatment T23, were only copper-oxychloride 50WP (0.3%) as dormant spray was applied. Similarly least die-back intensity of 0.87 per cent was recorded in pruned almond trees followed by seven fungicidal sprays at various phonological stages of almond tree growth.

Keywords: Die-back, *Diplodia seriata*, disease intensity, Fungitoxicants, pycnidia, pruned

Introduction
Almond (*Prunus amygdalus* Batsch.), belonging to family Rosaceae, is one of the most important nut crop cultivated in temperate regions of the world. The probable origin of almond is believed to be the Mediterranean region (Ladizinsky, 1999) [18]. It was spread by traders in ancient times along the shores of Mediterranean into northern Africa and southern Europe, and more recently distributed to other parts of world, notably California in United States (Zohary and Maria, 2000) [31]. Almond possesses wide spread popularity and is even considered as golden crop of California (Rogers, 1974) [25]. Its cultivation is mainly confined to the countries lying between 36º and 45ºN latitude (Rugini and Monastra, 1991) [27]. World shelled almond production has increased many fold from 1034 metric tonnes in 1995 to 2065 metric tonnes in 2007 (Ahmad and Verma, 2009) [2]. The total world production of almond was estimated 2.51 million metric tonnes in 2010 (FAOSAT, 2013). The main producers of almond (shelled product) include USA (40%), Spain (12.45%), Syria (6.77%), Iran (6.53%), Italy (6.38%), Morocco (4.70%), Algeria (3.39%), Tunisia (2.67%), Greece (2.83%) and Turkey (2.45%) (Ahmad and Verma, 2009) [2]. Almonds are the healthiest and most nutritious nuts of all, considered as a well-balanced cholesterol free food. The 100g of kernel contains 575 calories, fiber (12.2g), vitamin E (26mg), fat (49g), protein (21g), potassium (670mg), magnesium (268mg), phosphorus (484mg), calcium (265mg) and iron (3.5mg) (Ahmad and Verma, 2009) [2]. The medicinal benefits of almond include anti-inflammation, immunity boosting, anti-hepatotoxicity, improved complexion, improved movement of food through colon and prevention of cancer (Davis and Iwahashi, 2001; Puri, 2003) [11, 21]. Almond helps in reducing cardio-vascular diseases by having favourable effect on blood cholesterol levels (Ahmad and Verma, 2009) [2]. In India, almond is mainly grown in the state of Jammu & Kashmir (J & K) and Himachal Pradesh (H.P.) over an area of 23.81 thousand hectares,

yielding 11.47 thousand metric tonnes (Kumar, 2010) [17]. However, commercial cultivation of this nut fruit is mainly confined to the Kashmir Valley. In the Valley, it is mainly grown in district Budgam, Pulwama, Shopian, Gandarbal and other hilly areas occupying an area of 15.93 thousand hectares with a total production of 8.21 thousand MT (Anonymous, 2014) [5]. The productivity of almond in Jammu & Kashmir is 0.73 tonnes per hectare which is more than national productivity of 0.51 tonnes per hectare, but less than the global productivity of 1.15 tonnes per hectare (Anonymous, 2011) [4]. Almond is highly valuable crop and is also used as a filler crop in saffron fields. However, its yield as well as area under cultivation has shown a declining trend during the recent past. The reduction is attributed to several biotic and abiotic factors which include pests and diseases, occurrence of spring frost, poor pollination during cool, cloudy or rainy weather (Qureshi and Dalal, 1985; Connel, 2002) [23, 9]. In addition to this, lack of irrigation facilities, lack of improved varieties and pollinizers are also other important factors which add to declining trend in area and production. Although the almond tree is native to the Mediterranean region, this beautiful tree has adopted to the climate of Kashmir. In spite of favorable environmental conditions for almond cultivation, the tree is attacked by various diseases. During the present few years, almond orchards of the valley have been facing a serious threat due to die-back and twig blight diseases. These disease chiefly attacks the current season twig growth, which ultimately leads to the death of productive wood thereby causing significant reduction in crop yields.

Materials and methods

Perpetuation studies

The survival of the pathogen causing almond die-back was studied on pruned and un-pruned (intact) almond twigs during 2013 and 2014 in an almond orchard located at Nagam in district Budgam.

1 On over-wintered intact twigs

During November, 200 randomly selected current season twigs showing typical die-back symptoms were marked on almond trees. Throughout the growing season marked twigs were cut and brought to laboratory regarding the production and viability of conidia at weekly intervals from February onwards. The number of conidia and their viability was ascertained as per the method of Highberg and Ogawa (1986) [15].

i) Estimation of conidial production

The method given by Highberg and Ogawa (1986) [15] was adopted for estimation of conidial production. Diseased twigs bearing typical die-back symptoms, already marked for the purpose of experiment were brought to laboratory at weekly intervals throughout the growing season. The twigs were incubated at 20±1 ºC for 24 hours to get the pycnidia bulged. Five twig bits each of 1 cm^2 size were randomly selected, crushed in 50 ml of distilled water in a pestle and mortar and strained through a double layer of cheese cloth. Twenty five millilitres of this suspension was centrifuged at 3000 rpm for 15 minutes. After centrifugation, 20 ml of the suspension was drawn off with a pipette. The pellet was re-suspended in 5ml sterilized water and the number of conidia estimated as mean of eight haemocytometer readings per replication. The conidial production was computed on the bases of number per unit twig area (cm^2).

ii) Estimation of conidial viability

Spore germination method was used to study the viability of conidia in over-wintering twigs. Two drops of 50 µl from each processed sample were placed on a glass slide and incubated in a moist chamber at 25±1 ºC. After 24 hours incubation one drop of cotton blue in lactophenol was added to each drop and semi permanent slides were prepared by placing a 20×20 mm cover slip over each drop. The number of conidia in each drop and the number that germinated were recorded. Per cent spore viability was calculated as under:

$$\text{Per cent spore viability} = \frac{\text{No. of germinated spores}}{\text{No. of spores viewed}} \times 100$$

2 On pruned snags

Two hundred diseased pruned snags were collected from the orchard located in village Nagam in nylon wire-mesh bags during November for two consecutive years (2012 and 2013). The samples were allowed to over-winter on ground under the canopy of almond plantation in the same orchard. Observations regarding production and viability of conidia were recorded at weekly intervals throughout the growing season, by adopting the procedure similar to as discussed in 3.6.1.

3 Disease management through fungicidal application

Seven fungitoxicants viz. systemic, non-systemic and combiproducts at standard concentrations were evaluated for their efficacy in the field under natural conditions of disease development during the year 2013 and 2014. The evaluation of fungitoxicants was carried out on 14 to 16 year old seedling origin almond trees in a private orchard located at village Nagam of district Budgam. The fungicides were sprayed at different phenological stages of almond tree growth except check trees (only water was sprayed). The experiment was laid in randomized block design (RBD) with three replications, each tree representing one replication.

$$\text{Per cent disease incidence} = \frac{\text{Number of diseased twigs}}{\text{Total number of twigs observed}} \times 100$$

The disease intensity was calculated after rating the level of disease on branches and twigs on 0 to 5 scale of Crosse (1957) [10] as per the following key;

Scale used for categorizing die-back and twig blight on almond

Category	Numerical value	Criterion
I	0	No disease
II	1	0.1-10.0% of branch/twig surface area diseased
III	2	10.1-20.0% of branch/twig surface area diseased
IV	3	20.1-30.0% of branch/twig surface area diseased
V	4	30.1-40.0% of branch/twig surface area diseased or one side of branch/twig showing partial gardling
VI	5	More than 40% of branch/twig surface area diseased or complete girdling of the branch/twig. The branch above the girdled portion completely dried

The per cent disease intensity (PDI) was calculated as per the following formula given by FAO (1967) [12]:

$$\text{Per cent disease intensity} = \frac{\Sigma(n \times v)}{N \times S} \times 100$$

Where,
N = Number of branches or twigs in each category
V= Numerical value of each category
N = Total number of branches or twigs examined
S= Maximum numerical value

The phonological stages along with the fungitoxicants tested with their commercial name, common name, chemical name and concentration are given as under:

S. No.	Phenological stage	Commercial name	Common name	Chemical name	Conc. (%)
1	Dormant/75 per cent leaf fall	Blitox	Copper-oxychloride 50 WP	$CuCl_2$ $3Cu(OH)_2$	0.3
2	Bud swell	WAVE	Captan + Hexaconazole 75 WP	N-(trichloromethyl-thio-4-cyclo-hexane-1,2-dicarboximide) + (RS-2-(2,4-dichlorophenyl)-1-(1H-1,2,4-triazole-1-yl) hexane-2-ol	0.05
3	Bud burst	SAATHI	Carbendazim + Mancozeb 75 WP	Methyl-2-bezimedazole carbamate + Zinc ion and manganese ethylene bisdithiocarmate	0.25
4	Petal fall	Score	Difenconazole 25 EC	1-[2-[4-(4-chlorophenoxy)-2-chlorophenyl]-4-metyl-1,3-dioxolan-2-ylmethyl]-1H-1,2,4-triazole	0.03
5	Fruit let	Dithane M-45	Mancozeb 75 WP	Zinc ion and manganese ethylene bisdithiocarmate	0.3
6	20 days after fruit let formation	Bavistin	Carbendazim 50 WP	Methyl-2-bezimedazole carbamate	0.05
7	40 days after fruit let formation	SAATHI	Carbendazim + Mancozeb 75 WP	Methyl-2-bezimedazole carbamate + Zinc ion and manganese ethylene bisdithiocarmate	0.25

Results and discussion

The present study has established that the pathogen (*D. seriata*) perpetuating in the form of mycelium and pycnidia containing pycnidiospores throughout the winter on diseased intact twigs (Table 1) besides, pruned snags (Table 2) lying on orchard floor. However, diseased intact twigs were observed to be most important source of primary infection of almond die-back disease. These findings are supported by Beig (2003) [7] who reported that blighted almond twigs as important over-wintering units of pathogen *Cryptosporiopsis* sp. rather than diseased pruned snags. The diseased intact twigs exhibiting maximum conidial production between second to fourth week of May, coinciding with susceptible phenological stage (fruit let and fruit development) of almond tree growth. The production of viable conidia in intact diseased twigs and pruned snags increased from second to fourth week of May, which suggests that pycnidia on over-wintered twigs resume conidial production relatively at higher temperature regimes and the inoculums may build up to levels sufficient to initiate disease primary infection (June onwards). The observations are supported by the findings of Arauz and Sutton (1989a) [6] who reported that *Botryosphaeria obtusa* telomorph of *Diplodia seriata* thrives well under warm conditions at high relative humidity. Gradual increase in conidial production and viability of *Diplodia* spp. from late spring through summer months has also been reported by Amponsah *et al.* (2009) [3]. The pruned snags lying on the orchard floor exhibited viable conidial production only up to third week of June. There after the twigs decomposed and the pathogen could not be isolated. This could be attributed to microbial activity, saprophytic growth due to soil moisture which favoured decomposition of snags.

Table 1: Production and viability of *Diplodia seriata* conidia on over-wintered intact diseased twigs of almond during the years 2013 and 2014

Period of observation		(No. of conidia/cm^{-2} twig area)*× 10^4			Viability (%) **		
Month	Week	2013	2014	Pooled	2013	2014	Pooled
April	2nd	-	-	-	-	-	-
	3rd	0.014	0.027	0.021	-	-	-
	4th	0.042	0.042	0.042	14.67	16.33	15.50
May	1st	0.056	0.069	0.063	27.00	30.00	28.50
	2nd	0.083	0.097	0.090	51.00	54.33	52.67
	3rd	0.111	0.125	0.118	74.67	78.67	76.67
	4th	0.138	0.153	0.146	91.00	93.33	92.17
June	1st	0.125	0.138	0.132	84.00	88.67	86.34
	2nd	0.111	0.111	0.111	76.33	80.67	78.50
	3rd	0.083	0.097	0.090	63.33	67.33	65.33
	4th	0.069	0.056	0.063	51.33	54.00	52.67
July	1st	0.042	0.027	0.035	31.00	33.33	32.17
	2nd	0.014	0.014	0.014	17.33	21.67	19.50
	3rd	0.0	0.0	0.0	-	-	-

Although disposal of pruned snags from the orchards has been recommended for the management of various almond diseases, no work has been reported on the role of infected pruned snags lying on orchard floor in the perpetuation of die-back pathogen (*D. seriata*). The infected snags on orchard floor exhibited viable conidia up to third week of June with maximum production recorded between third week of May to first week of June. These conidia may be of much epidemiological significance because temperatures during this period remains generally favourable for primary infection. These observations are supported by the findings of Nishna and Mizhuhika (1981) [19] who reported that cut mulberry branches infected with Dogare blight (*Diplodia nomurai*) lying on the ground are most important sources of primary infection.

Table 2: Production and viability of *Diplodia seriata* conidia on over-wintered diseased pruned snags of almond during the years 2013-2014

Period of observation		(No. of conidia/cm^{-2} twig area)*× 10^4			Viability (%) **		
Month	**Week**	**2013**	**2014**	**Pooled**	**2013**	**2014**	**Pooled**
April	2nd	-	-	-	-	-	-
	3rd	0.014	0.014	0.014	-	-	-
	4th	0.027	0.042	0.035	12.00	14.67	13.34
May	1st	0.042	0.056	0.049	23.33	26.67	25.00
	2nd	0.069	0.069	0.069	46.33	50.33	48.33
	3rd	0.083	0.097	0.090	66.00	71.67	68.84
	4th	0.125	0.138	0.132	82.33	86.00	84.17
June	1st	0.111	0.125	0.118	70.67	75.00	72.84
	2nd	0.083	0.097	0.090	54.00	58.67	56.34
	3rd	0.069	0.069	0.069	29.33	32.67	31.00
	4th	0.0	0.0	0.0	-	-	-

Fungicides are frontline weapons against the pathogens and are still one of the most widely used means of combating plant pathogens. In the present study different fungicidal spray schedules comprising of seven different fungicides at different phenological stages were evaluated under field conditions against die-back disease of almond with a view to devise a suitable management capsule (Table 3).

The overall disease intensity in fungicidal treated trees was 4.52 per cent as against 10.23 per cent recorded in check. Treatment (T_1) set comprising of seven fungicidal sprays were copper-oxychloride 50WP (0.3%) was applied at dormant stage besides, captan + hexaconazole 75 WP (0.05%), carbendazim + mancozeb 75WP (0.25%), difenconazole 25 EC (0.03%), mancozeb 75 WP (0.3%), carbendazim 50WP (0.05%) and carbendazim + mancozeb 75WP (0.25%) applied at bud swell, bud burst, petal fall, fruit let, 20 days after and 40 days after fruit let stages, respectively proved significantly superior to all the treatments exhibiting minimum disease intensity of 1.37 per cent. The treatments T_2, T_5 and T_4 each comprising of six fungicidal sprays excluding dormant spray of copper-oxychloride 50WP in T_2, petal fall spray of difenconazole 25 EC in T_5 and bud burst spray of carbendazim + mancozeb 75WP in T_4 were the next best treatments exhibiting disease intensity of 1.72, 1.81 and 1.91per cent, respectively. However, treatment T_3 in which only bud swell spray of captan + hexaconazole 75 WP was missed exhibited disease intensity of 2.08 per cent. Treatment T_{23} in which only dormant fungicidal spray of copper-oxychloride was given and the remaining six sprays at various phenological stages were missed exhibited maximum disease intensity of 9.51 per cent. Treatment T_9 comprising of five sprays excluding dormant and bud swell sprays of copper-oxychloride and captan + hexaconazole, respectively exhibited disease intensity of 2.19 per cent. On the other hand treatment T_{15} also comprising of five sprays excluding dormant and 40 days after fruit let stage sprays exhibited disease intensity of 5.53 per cent. Similarly T_{16} comprising of four fungicidal sprays in which dormant, bud swell and bud burst sprays were missed exhibited disease intensity of 2.44 per cent, while T_{20} in which fruit let, 20 days and 40 days after fruit let stage sprays were missed exhibited disease intensity of 9.04 per cent.

The results are indication of the fact that fruit let, 20 and 40 days after fruit let stage are the most vulnerable phenological stages with regards to disease development, owing to the fact that maximum inoculum build up and disease spread occurred during summer months from June to July as has been envisaged in the present study and therefore fungicidal sprays at these stages becomes essential and unavoidable for effective disease management. Although, no systemic work with regards to framing a spray module for managing die-back disease of almond under Kashmir conditions have been carried over. However, the experiment of some of the fungicides for managing the almond die-back diseases have been reported by various workers. Olmo *et al.* (2017) [20] reported thiophanate-methyl as the most effective fungicide against *D. seriata* infecting branch of almond trees. Putto and Razdan (1988) [22] effectively controled almond twig blight (*Cryptosporiopsis* sp.) with three sprays of copper fungicides. Ragazzi and Surico (1992) [24] recommended benzamidazoles or triazoles to combater twig canker of almond. Chib (1994) recorded lowest incidence of blighted shoots in almond treated with blitox and dithane M-45. Adascaveg *et al.* (1998) [1] reported mancozeb as effective fungicide against twig diseases of almond. Beside alomd (Sharma, 2006) [28] and (Khan, 2010) [16] observed the effectiveness of carbendazim + mancozeb 75WP against *D. seriata* causing canker diseases in apple.

Table 3: Efficacy of various fungitoxicant spray schedules on incidence and intensity of almond die-back disease under field conditions (pooled 2013 and 2014)

Treatment Schedule	Per cent disease incidence*	Per cent disease intensity*	Mean of spray schedules in respect of intensity	Per cent disease control over check in respect of intensity
Seven spray schedule (T_1)	3.75 (2.06)	1.37 $(1.55)^{s}$	1.37	86.61
Six sprays excluding DM (T_2)	4.59 (2.23)	1.72 $(1.65)^{r}$	2.67	83.19
Six sprays excluding BS (T_3)	5.42 (2.35)	2.08 $(1.74)^{pq}$		79.67
Six sprays excluding BB (T_4)	5.42 (2.35)	1.91 $(1.71)^{qr}$		81.33
Six sprays excluding PF (T_5)	4.17 (2.23)	1.81 $(1.69)^{qr}$		82.31
Six sprays excluding FL (T_6)	8.17 (2.64)	2.53 $(1.87)^{m}$		75.27
Six sprays excluding 20 DAFF (T_7)	9.95 (2.95)	3.43 $(2.11)^{j}$		66.47
Six sprays excluding 40 DAFF (T_8)	13.34 (3.43)	5.22 $(2.49)^{g}$		48.97
Five sprays excluding DM and BS (T_9)	6.25 (2.41)	2.19 $(1.76)^{opq}$	3.87	78.59
Five sprays excluding BS and BB (T_{10})	7.09 (2.54)	2.53 $(1.85)^{mn}$		75.27
Five sprays excluding BB and PF (T_{11})	7.09 (2.54)	2.45 $(1.83)^{mno}$		76.05
Five sprays excluding PF and FL (T_{12})	7.09 (2.54)	2.29 $(1.78)^{nop}$		77.61
Five sprays excluding FL and 20 DAFF (T13)	11.25 (3.09)	3.93 (2.22)i		61.58
Five sprays excluding 20 and 40 DAFF (T14)	18.75 (4.14)	8.01 (3.00)e		21.76
Five sprays excluding 40 DAFF and DM (T15)	15.00 (3.66)	5.72 (2.62)f		44.09
Four sprays excluding DM, BS and BB (T16)	8.17 (2.64)	2.60 (1.89)lm	5.20	74.58
Four sprays excluding BS, BB and PF (T17)	9.00 (2.80)	2.94 (1.99)k		71.26
Four sprays excluding BB, PF and FL (T18)	9.00 (2.80)	2.79 (1.95)kl		72.73
Four sprays excluding PF, FL and 20 DAFF (T19)	12.09 (3.22)	4.35 (2.37)h		57.48
Four sprays excluding FL, 20 and 40 DAFF (T20)	21.67 (4.45)	9.09 (3.23)c		11.14
Four sprays excluding 20 DAFF, 40 DAFF and DM (T21)	20.00 (4.31)	8.56 (3.13)d		16.32
Four sprays excluding 40 DAFF, DM and BS (T22)	14.58 (3.74)	6.09 (2.63)f		40.47
Only dormant spray (T23)	23.75 (4.67)	9.55 (3.37)b	9.55	6.65
Mean	10.68	4.05	-	-
Check (Water spray)	25.84 (4.94)	10.23 (3.51)a	-	-
CD(p=0.05)	0.12	0.082	-	-

Figures in parenthesis are square root transformed values
*Average of three replications

Plant diseases have been effectively managed by logically integrating the various cultural practices. Since the fungicidal spray programme alone cannot control the onslaught twig and branch diseases in integrated approach involving elimination or at least reduction in the predisposing factors, prevention strategy coupled with therapeutic approach and orchard sanitation is essential. Treatments to prevent new infection through adoption of proper pruning and training, maintenance of general tree health with pruning and maintaining orchard hygiene only then can be the increasing incidence of twig and branch diseases in our orchards can be brought down. Autumn pruning irrespective of fungicidal sprays significantly reduced the disease intensity (Table 4) to 5.79 per cent as against 10.81 per cent recorded in un-pruned trees. Amongst the various treatment schedules in the present study, minimum disease intensity of 0.87 to 2.96 per cent was achieved in autumn pruned trees sprayed with six or seven times with various fungicides at different phenological stages. Maximum intensity of 9.72 to 10.26 per cent was however, recorded in un-pruned trees with one to two fungicidal sprays. The present findings corroborate with the observations of Guido (2003) [13] who successfully achieved 40 per cent reduction in twig blight infection as a consequence of autumn pruning. Beig (2003) [7] while working on almond twig blight also

achieved higher disease control compared to un-pruned trees. Pruning of dead and diseased branches and twigs, destruction of pruned snags from orchard floor, maintenance of tree health and orchard hygiene coupled with these practices use of fungicides for managing the wood tree diseases have also been advocated by Gupta (1975) [14], Bester *et al.* (2007) [8], Rolshausen *et al.* (2010) [26], Stephen Vann (2012) [29] and Twizeyimana *et al.* (2013) [30].

Table 4: Integrated management of die-back disease of almond involving autumn pruning and fungitoxicant sprays (pooled 2013 and 2014)

Treatment details	Per cent disease intensity Un-pruned*			Per cent disease control over check	Per cent disease intensity pruned*			Per cent disease control over check
	2013	2014	Mean		2013	2014	Mean	
Dormant spray (T_1)	11.29** (3.50)	9.23 (3.19)	10.26 (3.35)^{a}	5.09	7.43** (2.90)	6.08 (2.65)	6.76 (2.78)^{a}	10.94
Dormant and bud swell spray (T_2)	10.69 (3.41)	8.75 (3.11)	9.72 (3.26)^{ab}	10.08	7.19 (2.85)	5.89 (2.62)	6.54 (2.74)^{ab}	13.83
Dormant, bud swell and bud burst spray (T 3)	9.98 (3.30)	8.17 (3.02)	9.08 (3.16)^{bc}	16.00	6.74 (2.78)	5.52 (2.55)	6.13 (2.66)^{bc}	19.24
Dormant, bud swell, bud burst and petal fall spray (T_4)	9.56 (3.25)	7.82 (2.96)	8.69 (3.11)^{cd}	19.61	6.44 (2.72)	5.27 (2.50)	5.86 (2.61)^{cd}	22.79
Dormant, bud swell, bud burst, petal fall and fruit let spray (T_5)	9.14 (3.17)	7.48 (2.90)	8.31 (3.03)^{d}	23.13	6.01 (2.64)	4.91 (2.42)	5.46 (2.53)^{d}	28.06
Dormant, bud swell, bud burst, petal fall, fruit let and 20 days after fruit let spray (T_6)	5.68 (2.581)	4.64 (2.37)	5.16 (2.48)^{e}	52.27	3.26 (2.06)	2.66 (1.91)	2.96 (1.99)^{e}	61.00
Dormant, bud swell, bud burst, petal fall, fruit let, 20 and 40 days after fruit let spray (T_7)	1.46 (1.567)	1.20 (1.48)	1.33 (1.53)^{f}	87.70	0.96 (1.47)	0.78 (1.33)	0.87 (1.40)^{f}	91.54
Check (Water spray)	11.92 (3.58)	9.69 (3.25)	10.81 (3.42)^{g}	-	7.94 (2.94)	7.23 (2.89)	7.59 (2.92)^{g}	-

CD (p=0.05) CD (p=0.05)
Treatment = 0.07
Treatment = 0.08
Un-pruned = 0.08
Un-pruned = 0.09
Treatment × Un-pruned = 0.10
Treatment × Un-pruned = 0.12
Figures in parenthesis are square root transformed value
*Average of three replications

Conclusion

Integration of orchard sanitation encompassing destruction of fallen diseased leaves, pruned snags and infected intact twigs, on which pathogen perpetuates and spraying with specific fungitoxicant especially at critical phenological stage (fruit let to fruit development) helps in managing the disease.

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