Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(5): 900-902
Received: 04-06-2020
Accepted: 08-08-2020

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Effect of botanicals on viral disease incidence and yield related parameters of watermelon (*Citrullus lanatus* (Thunb)

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Abstract
Watermelon (*Citrullus lanatus* (Thunb) is a very common summer fruit crop in India. This crop is affected by a number of viral diseases like cucumber mosaic virus, watermelon mosaic virus, zuchini yellow mosaic virus, cucumber mosaic virus, papaya ring spot virus, watermelon chlorotic stunt virus and melon necrotic spot virus. The field experiment was conducted at Student Instructional Farm, Narendra Deva Univeristy of Agriculture and Technology, Kumarganj, Faizabad-224229 (U.P.) during 2007-08 and 2008-09. Four botanicals *viz. Boerhaavia diffusa (*root extract), *Clerodendrum aculeatum and Azadirachta indica* (leaf extract) and bark of *Terminalia arjuna* (bark extract) were evaluated against viral diseases of watermelon @ 10% concentration at fortnightly intervals. Results indicated that seed treatment fallowed by six foliar sprays with *Boerhaavia diffusa (*root extract) was the most effective treatment. Maximum vine length (3.93 m), fruit weight (3.62 kg/plant), number of fruit (4.60 fruit/plant), fruit diameter (21.16 cm), fruit yield (16.52 kg/plot) and diseases initiation (66.5 DAS) with minimum disease incidence (37.68%) was recorded in the same treatment during both years, respectively.

Keywords: Watermelon, *Citrullus lanatus*, viral diseases and botanicals etc.

Introduction
Watermelon (*Citrullus lanatus* (Thunb) Mastum and Nakai, synonyms: *C. vulgaris*) is a very common summer crop in World. In India, it is also known as Tarbuj, Tarmuj, Kalindi and Kalinda. It is also grown in lower Himalayan region to other parts of India such as Punjab, Haryana, Karnataka, Assam, West Bengal, Orissa, Himanchal Pradesh, Tamil Nadu Rajasthan and Uttar Pradesh. It is an excellent source of vitamin A and C and one cup of waterelon juice contain 48.59 mg of vit. C and 556.32 IU of vit. A besides 48 calorie of energy. The fruit contains 92% water, 0.2% protein, 03% minerals and 7.0% carbohydrates. (Thamburaj and Singh, 2000). In India, it is grown in an area of about 200,000 ha with production of 25,500 tones and productivity is 127.50 q/ha (Anonymous, 2008). The low productivity of watermelon is mainly due to various diseases incited by fungi, bacteria, viruses, nematodes and phytoplasma. Among viruses, watermelon mosaic virus, cucumber mosaic virus etc. are gaining importance in recent years. These viruses are major limiting factor in watermelon production. Sometime it is difficult to find even a single plant free from infection at the end of the growing season, and thus results in severe yield reduction (Varma and Giri, 1995). These viruses cause severe mosaic mottling, blistering and malformation of leaves of watermelon (Greber, 1978; Vani, 1987). At present almost all the cultivated varieties are found to be susceptible for virus infection. At present, control of viral disease has become a great concern to world scientists. It is well established that virus is a living organism and can survive outside a host for a considerable time; however they cannot multiply without a living host. Usually viral infestation can be controlled by preventing their vectors to attack plants as there was a positive correlation between disease incidence and population of the vector (Bhagabati and Goswami, 1992; Nath *et al*., 1992). Synthetic chemicals cause environmental pollution, health hazards and phytotoxicity besides their very high cost. Use of such chemicals can be avoided by some preventive measures/immunization through antiviral substance of plant origin. These substance are non chemicals, non hazardous, easily biodegradable, did not leave any residual effect and are eco-friendly besides their very low cast.

Materials and Methods
The study was conducted at the Student Insrtuction Farm of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (Uttar Pradesh), India. during summer seasons of 2007-08 and 2008-09.

The treatments (seed +foliar sprays) used in the study were root extracts of *B. diffusa*, leaves of *Clerodendrum aculeatum*, leaves of *Azadirachta indica* and bark of *Terminalia arjuna*. The field experiment was laid out in a randomized block design with three replications. Roots of *Boerhaavia diffusa*, leaves of *Clerodendrum aculeatum, Azadirachta indica* and bark of *Terminalia arjuna* were collected and allowed to dry under shade at room temperature. Dried roots, leaves and bark were ground to powder and stored at room temperature. The crude extracts were prepared by making the suspension of root, leaf and bark powder separately in the tap water (1g/10 ml). the pulp was strained through two folds of chees cloth and the homogenate was clarified by centrifugation at 3000 g for 15 minutes. The supernatants were used for experimental works. Seeds of variety Sugar Baby were soaked in *B. diffusa* (root extract), *C. aculeatum* and *A. indica* (leaf extract) and *T. arjuna* bark extract @ 10% cncentration separately for over night. In controls seeds were soaked in water alone for the same time. The first spray of plant extract was done at cotyledonous stage and second, third, fourth, fifth and sixth sprays were done at fortnightly intervals following the first spray. In control water alone was sprayed. Observation were recorded on first appearance of disease, disease incidence, plant height, number of fruits, fruit yield and yield losses.

$$\text{per cent disease control} = \frac{C - T}{C} \times 100$$

$$\text{Yield loss} = \frac{\text{Yield of protected plant - Yield of unprotected plant}}{\text{Yield of protected plant}} \times 100$$

Results

Effect on Incidence of viral infection

There was a significant effect of all phytopesticides on the incidence of viral infection which indicated a gradual decrease in disease incidence with corresponding increase in number of sprays with *B. diffusa* (root extract), *C. aculeatum* and *A. indica* (leaf extract) and *T. arjuna* (bark extract). Maximum reduction in disease incidence (37.68 per cent) was recorded in seed treatment + 6 foliar sprays with *B. diffusa* followed by seed treatment + 6 foliar sprays of *A. indica* leaf extract (39.46%) T_{10} (44.77%), T_5 (50.06%), T_{12} (53.70%), T_7 (53.73%), T_6 (59.88%), T_8 (62.68%), T_1 (75.28%), T_3 (76.85%), T_4 (78.58%) and T_2 (77.85%) and T3 (82.35).

Effect on Vine length (m)

There was a significant influence of phytopesticides against natural viral infection, on vine length at different growth stages (table-1). It was revealed that virus infestation reduced plant height irrespective of growth stages. Maximum vine length (3.93 m) was recorded inT_9 which was at par with the treatment T_{11} (3.70m) and significantly superior over rest of the treatments.

Effect on number of fruits plant^{-1}

Maximum number of fruits per plant (4.60) was recorded in T_9 which was at par with T_{11} (4.36) and significantly superior over rest of the treatments.

Effect on fruit diameter (cm)

A gradual increase in fruit diameter was recorded in case all the botanicals with increase in number of sprays. Maximum fruit diameter (21.16 cm) was recorded in the treatment T_9 which was at par with T_{11} (20.05) and significantly superior over rest of the treatments.

Effect on fruit weight (kg)

A gradual increase in fruit weight was recorded in case of all the botanicals with increase in number of sprays. Maximum fruit weight (3.62 kg/plant) was recorded in treatment T_9 which was at par with T_{11} (3.40) and significantly superior over rest of the treatments.

Effect on fruit yield plot^{-1} (kg)

It was observed that there was a significant difference among the treatments in both healthy and infested group of plants for yield. Phytopesticide treated plants performed better than as compared to nontreated (control).Result presented (Table -1) indicated that significant increase in fruit yield per plant for all the botanicals with increase in number of sprays. Maximum fruit yield per plot (166.52 kg/plot) was recorded in treatment T_9 which was significantly superior over rest of the treatments.

Avoidable yield loss (%)

Maximum avoidable yield loss (48.29%) was recorded in T_9 which was significantly higher over rest of the treatments and minimum per cent avoidable yield losses were recorded in treatment T_{13} (control) which was significantly lower over rest of the treatments.

Discussion

Present study on the evaluation of botanicals for antiviral efficacy revealed that 6 foliar sprays along with seed treatment with *B. diffusa*, root extract (66.50 DAS) was the most effective treatment, which significantly delayed appearance of symptom and was found significantly superior over rest of the treatments. A gradual decrease in disease incidence with foliar sprays along with seed treatment was recorded with all the botanicals. Most effective botanical found was *B. diffusa* root extract which exhibited minimum disease incidence.

Gradual increase in vine length, number of fruits per plant, fruit diameter, fruit weight, fruit yield per plot and avoidable yield loss, was recorded in seed treatment +six foliar sprays with all the botanicals. *B. diffusa* root extract was found most effective, which exhibited maximum vine length, number of fruits per plant, fruit diameter, fruit weight, fruit yield per plot and avoidable yield loss.

Awasthi *et al*. (1984) [1] observed that pre-inoculation sprays of *Boerhaavia diffusa* root extract were effective against tobacco mosaic virus in tobacco, cucumber mosaic virus and TMV in tomato, *cucumber green mottle mosaic virus* in melon, *sunnhemp rosette virus* in *Crotolaria juncea* and *Gomphrena globosa.* Verma *et al*. (1985) [9] suggested possible control of natural infection of mungbean yellow mosaic virus in mungbean and urdbean by plant extracts. The infection on these crops MYMV was suppressed by partially clarified leaf extract of *Clerodendron fragrans, Aerva sanguinalonta* and root extract of *B. diffusa*. The treatments were administered as foliar spray of 4%, every after 3-4 day from the seedling stage. The extract from *C. fragrans* reduced the infection by 60 per cent while the other extract delayed the appearance of disease symptoms. The treatment also increased the nodulations and yield. Singh (2002) and Singh and Awasthi (2002) [2, 3] reported that aqueous root extract of *B. diffusa* effectively reduced mungbean yellow mosaic and bean common mosaic virus disease in mungbean and urdbean

alongwith increased grain yield in field condition. Later Awasthi and Kumar (2003a, b), Kumar and Awasthi (2003a, b) revealed that weekly sprays of aqueous root extract of *B. diffusa* significantly prevented infection, multiplication and spread of *cucumber mosaic virus, bottle gourd mosaic virus, cucumber green mottle mosaic virus, pumpkin mosaic virus* in cucurbitaceous crops (Singh and Awasthi, 2004; Singh *et. al.*, 2004; Verma and Awasthi, 1979 a, b and c; Singh and Awasthi, 2009) [4, 5, 6, 7]. Singh *et al* (2011) [8] reported that the maximum reduction in the incidence of mungbean yellow mosaic virus disease was observed in mungbean and urdbean when these crops were given six sprays of each botanical separately..

Table 1: (Pooled data of 2007-08 and 2008-09) Effect of Boerhaavia diffusa root extract on viral disease incidence and yield related parameters of watermelon.

Treatments	Disease incidence (%)	Vine length (m)	No. of fruits/ plant	Fruit weight (kg/plant)	Fruit diameter (cm)	Fruit yield (kg/plot)	Aoidabl yield loss kg/plot (%)
$T_{1=}$ Seed treatment wit *Boerhaavia diffusa* root extract (BD) @ 10%	75.28	2.22	3.41	1.75	11.85	59.67	9.05
T_2 = Seed treatment with *Clerodendrum aculeatum* leaf extract (CA) @ 10%	77.85	2.05	3.32	1.45	11.09	48.14	4.6
T_3 = Seed treatment with *Azadirachta indica* leaf extract (AI) @ 10%	76.76	2.15	3.38	1.60	11.58	56.10	7.19
T_4 = Seed treatment with *Terminalia arjuna* bark extract (TA) @ 10%	78.58	1.95	3.25	1.33	10.59	43.22	2.55
T_5 = Foliar sprays of BD	50.06	3.52	4.10	3.00	18.10	123.00	38.24
T_6 = Foliar sprays of CA	59.88	2.40	3.75	2.65	15.01	99.37	23.90
T_7 = Foliar sprays of AI	53.73	3.14	3.85	2.81	14.29	110.49	32.17
$T_{8=}$ Foliar sprays of TA	62.68	2.13	3.46	2.00	13.25	69.20	15.75
T_9 = T1+T5	37.68	3.93	4.60	3.62	21.16	166.52	48.29
T_{10} = T2+T6	44.77	3.19	4.11	2.89	18.78	118.77	32.72
T_{11} = T3+T7	39.46	3.70	4.36	3.40	20.05	148.24	41.36
T_{12} = T4+T8	53.70	2.46	3.90	2.39	15.13	93.21	20.35
T_{13} = Control (water alone)	82.35	1.90	3.18	1.15	10.13	36.57	10.00
SEm±	1.047	0.114	0.493	0.216	0.524	5.092	
CD (P=0.05)	3.045	0.331	1.439	0.629	1.525	14.864	

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