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Effect of Silicon and Botanicals on Yellow Mosaic Viral Diseases of Urdbean (*Vigna mungo* L. Hepper)

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ABSTRACT

An experiment was designed to test the efficacy of silicon and botanical extracts on the yellow mosaic virus of urdbean. Maximum reduction in disease incidence recorded were 41.38 percent in urdbean by 2.0 ml silicon + 2 foliar sprays of *Tinospora cardiofolia* @ 10%. Maximum plant height was recorded at 20, 40 DAS and harvesting stage (19.92, 42.86 and 44.88 cm, respectively), number of leaves plant^{-1} at 20 and 40 DAS (6.26 and 12.62, respectively), number of branches plant^{-1} at 40 DAS and harvesting stage (3.93 and 4.20), 50% flowering (40.7 DAS), number of pod plant^{-1} (19.92), number of grain pod^{-1} (5.41), length of pod (4.27 cm), 1000 seed weight (46.00 g), grain yield (14.81 q ha^{-1}), stover yield (22.42 q ha^{-1}), biological yield (54.33 q ha^{-1}), harvest index (51.90%), cost of cultivation ha^{-1} (Rs. 25640), gross income ha^{-1} (Rs. 104650), net returns ha^{-1} (Rs. 79010) and B:C ratio (3.082) were found significantly superior over the rest treatments. Results indicated a gradual decrease in disease incidence in all treatment by different doses of Si and botanicals. Most effective treatment was found T_4 followed by T_8, which was also effective and reducing the disease incidence and maximum avoidable yield loss.

Key words: Silicon, Botanicals, Yellow mosaic, Viral diseases, Urdbean

Urdbean [*Vigna mungo* (L.) Hepper] (2n = 22) is indigenous to India or Indo-Burma region and one of the most important self-pollinated, short-duration grain leguminous crop grown extensively in major tropical and sub-tropical countries of the world [1]. Urdbean suffer a large number of diseases incited by fungi, bacteria, viruses, and nematodes. Among viral diseases, yellow mosaic disease is caused by mungbean / urdbean yellow mosaic virus, a member of geminivirus group. It is transmitted through whitefly (*Bemisia tabaci* Gen.), and produces a very severe disease. The paired particles of the causal virus measure 30 × 15 nm having ssDNA [2]. Yield losses due to this disease vary from 5 to 100 percent depending upon disease severity, susceptibility of cultivars and population of whitefly [3-5]. The infection not only drastically reduces yield but also severely impaired the grain size and quality. So far, no feasible measures are available to control this disease. Apart from this, the quality of produce, deteriorated due to the excessive use of chemical insecticides to protect the crops against viruses by killing their vectors in the field. Chemicals used to protect crops cause human health hazards, environmental pollution and also not cost effective. Now alternate ways to protect these crops have been tried by the use of substances of plant origin as antiviral agents, which have proved to be successful in the management of urdbean crops against viral diseases. Therefore, plant products were tested to protect the urdbean for yellow mosaic virus infection under field conditions.

Role of silicon (Si) in plant health and growth has been investigated in silicon accumulating crops and it seemed significantly effecting [6]. Research evidences proved that adequate uptake of Si can increase the tolerance of agronomic crops to both abiotic and biotic stress [7]. Effects of Si on yield are related to the deposition of the element under the leaf epidermis which results a physical mechanism of defense, reduces lodging, increases photosynthesis capacity and decreases transpiration losses [8]. Its supply is essential for healthy growth and economic yield. Silicon interacts favorably with other applied nutrients and improves their agronomic performance and efficiency in terms of yield response. Hence, Si management is essential for increasing productivity [9]. Accumulation of Si in leaves and tissues in addition to conferring resistance against fungal, bacterial diseases and insect pests, can improve erectness of leaves, increase yield and alleviate water stress, salinity stress and nutrient deficiency or toxicity stresses as well. Si is also considered as an environment-friendly element in relation to soils, fertilizers and plant nutrition [7].

Besides blackgram, Mungbean yellow mosaic virus (MYMV) also affect number of pulse crops including greengram (*Vigna radiata*), mothbean (*Vigna aconitifolia*), pigeonpea (*Cajanus cajan*), French bean (*Phaseolus vulgaris*),

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cowpea (*Vigna unguiculata*), Dolichos (*Lablab purpureus*), horsegram (*Macrotyloma uniflorum*), and soybean (*Glycine max*) of the family Malvaceae and Solannceae [10]. This disease is known popularly known as "Yellow plague" [11].

Among the diseases, viral diseases are the major threat which causing serious losses to yield and quality of crop products. These losses can be minimized by adopting preventive measure/immunization through antiviral agent. Protection of crop plants from the ravages of pests and diseases by the use of synthetic pesticides has been the usual practice for many years. The Indian farmers usually use more pesticides than the farmers of neighboring countries. The indiscriminate application of pesticides not only adds to high input cost but also leads to undesirable effects to the environment and to human health. The plant disease management by using toxic chemicals is not preferred now days. Therefore, other alternative method is being preferred for the management of yellow mosaic viral disease of urdbean. In recent years, several plant products have been demonstrated to be useful for the management of viral diseases of crop plant [12-13]. Botanical pesticides are gaining status and recognition as a possible method for practical control of diseases of crop plants. Keeping this in view, the present study was undertaken to evaluate the efficacy of the Si and botanicals against viral diseases under field conditions.

METHODS AND MATERIALS

The field experiment was conducted at Agricultural Research Farm of IFTM University, Lodhipur Rajput, Moradabad, Uttar Pradesh during *summer* season 2017-18. The experiment consisting of 8 treatment combinations viz. T_1-Control (untreated), T_2- 1.0 ml silicon + 2 foliar spray of *Tinospora cardiofolia* @ 10%, T_3- 1.5 ml silicon + 2 foliar spray of *Tinospora cardio folia* @ 10%, T_4-2.0 ml silicon + 2 foliar spray of *Tinospora cardio folia* @10%, T_5- 0.5 ml silicon + 2 foliar spray of *Terminalia arjuna* @ 10%, T_6- 1.0 ml silicon + 2 foliar spray of *Terminalia arjuna* @ 10%, T_7- 1.5 ml silicon + 2 foliar spray of *Terminalia arjuna* @ 10% and T_8- 2.0 ml silicon + 2 foliar spray of *Terminalia arjuna* @ 10%. The urdbean cultivar *Azad 2* is susceptible to yellow mosaic virus was laid out in Randomized Block Design with three replications. Healthy seeds of urdbean cultivar *Azad 2* were directly sown in 30 cm wide row spacing @ of 25 kg seed ha^{-1}. The standard agronomical practices were followed to grow the crop. The antiviral agents/botanical biopesticides were prepared by crushing different parts of plants, separately with distilled water (w/v) in a pestle and mortar. Crude extracts were prepared by making suspension in tap water (1: 10). The pulp was strained through two folds of cheese cloth and the homogenate was subjected for centrifugation at 8000 g for 15 minutes at 4°C. Sticky material was added into supernatants for sticking on the leaves of host plants [14]. The first spray of plant extracts /botanical biopesticide (antiviral agents), @ 10% was done after first appearance of disease. In control plots, water alone was sprayed instead of plant extracts. Observations were recorded at 15 days intervals starting from 15 days after sowing upto the harvesting of crop.

Per cent disease incidence

Mungbean yellow mosaic virus (MYMV) severity was calculated by using the modified scale of All India Coordinated Research Project on MULLaRP given by Alice and Nadarajan [15] and the per cent disease index was calculated by using the formula given by Wheeler [16].

$$\text{Percent disease intensity (PDI)} = \frac{\text{Sum of all numerical value}}{\text{Total number of leaves examined} \times \text{Maximum grade}} \times 100$$

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

Whereas: C = Per cent disease incidence in untreated (control) Plant, T = Per cent disease incidence in treated plants

RESULTS AND DISCUSSION

Data presented in (Table 1-3) revealed significant effect of all the treatments on the management of urdbean Yellow Mosaic Virus. The evaluation of plant products against yellow mosaic virus disease of urdbean exhibited reduction in disease incidence. In case of urdbean, minimum disease incidence of 41.38 percent was recorded with T_4 (2.0 ml silicon + 2 foliar spray of *Tinospora cardiofolia* @10%) followed by T_8, T_3, T_6, T_5, T_7 and T_2. On the other hand, control plot showed severe infection with higher disease incidence (57.34%). Maximum reduction (27.34%) in disease incidence was recorded in T_4 followed by T_8, T_3, T_6, T_5, T_7 and T_2. Maximum plant height was also recorded in T_4 at 20, 40 DAS and at harvesting stage (19.92, 42.98 and 44.48 cm, respectively), which was at par with T_8 and T_7 and statically significantly greater than the rest of the treatments, maximum number of leaves at 20, 40 DAS and at harvesting stage (6.26, 12.62 and 3.19, respectively) were found in T_4, which was statically at par with the treatment T_6 and T_7. Maximum number of branches $Plant^{-1}$ at 40 DAS and harvesting stage (3.93 and 4.20, respectively) were found in T_4 which was significantly superior over the rest treatments. Maximum 50 percent flowering were observed in T_7 (40.7 days), which were at par with the treatment T_2 and T_6. Maximum number of pod $plant^{-1}$ (19.92) were found inT_4 and statically at par with the treatment T_8 and T_7, T_7 and T_3. Maximum pod length were observed in T_4 (5.41 cm) followed by T_8, T_7, T_6, T_5, T_3, T_2 and T_1 (control). Maximum 1000 seed weight (46 g), grain yield (14.81 q ha^{-1}), Stover yield (22.42 q ha^{-1}), Biological yield (54.33 q ha^{-1}), harvest index (51.90 %) was recorded in T_4. Whereas, maximum gradual increase in cost of cultivation (Rs. 25,640), gross returns (Rs. 104,650), net returns (Rs. 79,010) and benefit cost ratio (3.08) was also recorded in same treatment.

The inhibitory effect of *Terminalia arjuna* and *Clerodendrum aculeatum* may be due to preexisting resistance inducers in these plants [17-18]. These botanicals induce strong systemic resistance against several viruses in hypersensitive as well as systemic hosts [19-21]. Awasthi *et al.* [22] suggested that virus inhibition occurred through an alternation in the host physiology that inhibited virus multiplication in the cells. It also acted as a repellent as well as antifeadent for vectors [23]. Verma and Verma [24] reported that leaf extract of *Clerodendrum aculeatum* along with soil amendment of its dry powder showed two folds increase in nodulation and grain yield with 50% reduction in incidence of mungbean yellow mosaic virus disease. Verma and Singh [25] reported that inhibition of natural mungbean yellow mosaic virus infection by spraying with leaf extract of *Clerodendrum aculeatum*, together with soil amendment with dry leaf powder or fresh extract. The mungbean and urdbean plants may be protected against infection and spread of mungbean yellow mosaic virus by aqueous extracts of *B. diffusa* roots, *C. aculeatum* and *A. indica* leaves. If strategies are developed to prolong the effect of this inhibitor, it may prove as a source of possible prophylaxis against the yellow mosaic disease of mungbean at commercial levels. Since, the antiviral substance present in these plants is of the same origin like many other common constituents of a majority of plant systems, it may be easily absorbed into the leaves and translocated systemically to induce the production/synthesis of some protein (s) which are actually antiviral and defends the plants against infection.

Table 1 Effect of silicon and botanicals on plant height (cm) and number of leaves plant^{-1} of Urdbean

Treatments	Plant height (cm) at			Number of leaves plant^{-1} at		
	20 DAS	40 DAS	Harvest stage	20 DAS	40 DAS	Harvest stage
T_1: Control	14.56	33.82	36.06	3.12	7.14	1.59
T_2: 0 ml silicon + 2 foliar spray of *Tinospora cardio folia* @ 10%	17.26	37.75	40.06	4.46	8.87	2.11
T_3: 1.5 ml silicon + 2 foliar spray of *Tinospora cardio folia* @ 10%	17.81	39.44	40.15	4.67	9.59	2.60
T_4: 2.0 ml silicon + 2 foliar spray of *Tinospora cardio folia* @10%	19.92	42.86	44.88	6.26	12.62	3.19
T_5: 0.5 ml silicon + 2 foliar spray of *Terminalia arjuna* @ 10%	18.69	39.90	40.74	4.75	11.14	2.79
T_6: 1.0 ml silicon + + 2 foliar spray of *Terminalia arjuna* @ 10%	18.80	40.34	42.62	4.84	11.38	3.09
T_7: 1.5 ml silicon + 2 foliar spray of *Terminalia arjuna* @10%	18.52	41.12	43.64	5.34	11.97	3.00
T_8: 2.0 ml silicon + 2 foliar sprayof *Terminalia arjuna* @ 10%	19.37	42.04	44.03	5.86	12.26	2.95
C.D at 5%	0.159	0.318	0.175	0.189	0.100	0.189
SE(m)±	0.487	0.973	0.536	0.578	0.306	0.578

Table 2 Effect of silicon and botanicals on number of branches plant^{-1}, 50 % flowering, pods length (cm), number of grains pod^{-1} and 1000 seed weight (g) at 40 DAS and at harvesting of urd bean

Treatment	Branches plant^{-1}		50% flowering	No. of pods plant^{-1}	Pods length (cm)	Number of grains pod^{-1}	1000 seed weight (g)
	40 DAS	Harvesting Stage					
T_1	1.13	2.58	35.0	12.88	2.93	4.76	41.00
T_2	2.20	3.30	39.3	17.91	3.43	4.81	42.33
T_3	1.80	3.67	40.7	18.42	3.53	4.89	42.67
T_4	3.93	4.20	43.7	19.92	4.27	5.41	46.00
T_5	2.63	3.37	39.3	17.35	3.43	4.95	42.00
T_6	2.83	3.43	40.3	17.46	3.50	5.10	42.67
T_7	3.27	3.57	42.3	18.83	3.63	5.26	44.33
T_8	3.50	3.70	43.0	18.87	3.80	5.33	44.67
C.D at 5%	0.179	0.154	0.697	0.259	0.177	0.287	1.347
SE(m)±	0.548	0.472	2.135	0.793	0.542	N.S.	N.S.

Table 3 Effect of silicon and botanicals on PDI, PDC, grain yield (q ha^{-1}), stover yield (q ha^{-1}), biological yield (q ha^{-1}), harvest index (%), cost of cultivation (Rs. ha^{-1}), gross income (Rs. ha^{-1}), net return (Rs. ha^{-1}) and benefit cost ratio of urd bean

Treatments	PDI	PDC	Grain yield (q ha^{-1})	Stover yield (q ha^{-1})	Biological yield (q ha^{-1})	Harvest index (%)	Cost of cultivation (Rs ha^{-1})	Gross return (Rs ha^{-1})	Net return (Rs ha^{-1})	B: C ratio
T_1	57.34	0.00	8.210	14.783	24.897	31.62	18000	44473	26473	1.47
T_2	50.42	12.05	10.370	16.400	36.322	44.41	21400	72600	51200	2.39
T_3	48.16	15.98	11.933	17.993	40.2	40.35	23432	82906	59474	2.54
T_4	41.38	27.81	14.81	22.423	54.333	51.90	25640	104650	79010	3.08
T_5	42.82	25.31	11.153	19.193	38.233	44.51	21000	71853	50853	2.42
T_6	42.48	25.88	11.537	20.740	41.637	39.61	21400	81260	59860	2.80
T_7	43.00	24.97	12.047	20.457	45.16	47.43	23432	85525	62093	2.65
T_8	41.53	27.55	13.003	21.573	49.227	46.73	25640	92509	66869	2.61
SEm±	0.405	0.676	0.415	0.825	0.688	2.001				
CD at 5%	1.241	2.069	1.271	N.S.	2.108	N.S.				

The role of silicon as a nutrient for plant growth was overlooked becomes its natural abundance. Soluble silicon reduces off spring's production and population fitness of phloem feeding aphids and whitefly. Both soil and foliar application of calcium silicate increased the mortality of nymph of white fly [26]. The cutcle-silica double layer mechanically impedes penetration process thus disrupt infection process [27]. The soluble silicon produces phenolics and phytoalexin in response to infection [28].

Silicon increase resistance against pests and diseases, improves water economy by reducing transpiration rate, alleviates the ill effects of a biotic stresses, growth and enhances crop yield. Cost of cultivation, gross returns, net returns and benefit: cost increased with increasing levels of phosphorus up to 90 kg P_2O_5 ha^{-1} as reported by [29-31].

CONCLUSION

As we know any plant viral disease cannot be mange directly only, we can apply some preventive measure. So, it concluded that the silicon and botanicals play role as a virus inhibitory agent (VIA) in the plant and botanicals also control the vector.

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