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Effect of dates of sowing and methods of planting on viral diseases of muskmelon

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ABSTRACT

Virus diseases are one of the major constraints in the cultivation of muskmelon crop under Punjab conditions. For virus disease management cultural control methods *viz*., date of sowing, methods of planting, crop rotation, intercropping and border row cropping are the most important strategies. During this study different cultural practices *viz.,* date of sowing/transplanting and methods of sowing/transplanting were tested for the management of the viral disease in muskmelon in 2016-17 and 2017-18. Five dates of sowing *viz.,* 5th February, 15th February, 25th February, 5th March and 15th March were tested along with three methods of planting *viz*., transplanting, direct sowing and tray transplanting. During the study zucchini yellow mosaic virus, cucumber mosaic virus-I and begomovirus infection was recorded in muskmelon crop. Crop transplanted on 15th March had minimum per cent disease incidence of 39.80% followed by crop transplanted on 5th March whereas maximum per cent disease incidence was observed in crop transplanted on 5th February (71.90%) followed by crop transplanted on 15th February (63.90%). In direct sowing maximum per cent disease incidence was observed in crop sown on 15th February (58.40%) followed by crop sown on 5th February (55.00%) whereas, minimum per cent disease incidence was observed in crop sown on 15th March (41.70%) followed by crop sown on 5th March (48.40%). Tray transplantation of plants on 15th March resulted in minimum per cent disease incidence of 35.40% followed by crop transplanted on 5th March (41.80%) however maximum per cent disease incidence was observed in tray transplantation of crop on 5th February (57.90%) followed by tray transplantation on 15th February (52.80%). Least loss in the average marketable fruits and fruit weight was also observed in 15th March and 5th March sown/ transplanted crop. Similar to the pathological parameters late sowing of the crops also positively affected the yield parameters of the muskmelon crop.

Key words: Muskmelon, cultural practices, cucumber mosaic virus, begomovirus, zucchini yellow mosaic virus

Melon (*Cucumis melo* L.) is a fresh vegetable and dessert fruit that can also be cooked, dried, or processed for juice and flavoring. Melon seeds can be roasted and eaten like nuts which are sources of high-quality cooking oil along with protein-rich seed flour (McCreight *et al*., 2011). Like other cucurbits, melons are infected with various viruses around the world. They are susceptible to various viral diseases and are attacked by more than 30 viruses (Zitter *et al*., 1996). Earlier, cucumber mosaic virus, zucchini yellow mosaic virus, melon necrotic spot virus, muskmelon yellows virus, and cucumber green mottle mosaic virus were recorded to infect the muskmelon in different parts of world including India (Sharma *et al.,* 2012; Yin *et al*., 2014). Besides above mentioned viruses, different DNA viruses *viz.* Tomato leaf curl New Delhi virus and Tomato leaf curl Palampur virus had also been found to infect the muskmelon in Punjab and other parts of world (Dhkal *et al*., 2020a; Dhkal *et al*., 2020b).

Unlike fungal and bacterial plant pathogens, there is no economically feasible chemical control measure available in case of the viral plant pathogens (Narayanasamy, 2011). Control of the insect vectors of viruses, any alternate weed host of the viruses, breeding for the resistant varieties and alteration in different cultural practices are some measures that achieve some success in controlling different viral diseases (Provvidenti, 1991). Different cultural practices *viz.* change in date of sowing, methods of planting, crop density, mulching, removal of host weed plant and use of border crop plants can play an important role in the management of viral diseases either by directly affecting the survival

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and transmission of the virus or indirectly affect the transmission of viruses from diseased to healthy plants by changing the behavior of their vectors.

Among different cultural practices, date of sowing is one of the important practices that was used to control the viral diseases in various crop plants throughout the world. Concept of using early or late date of sowing is to avoid high viral inoculum and vector population at the susceptible stage of the crop that saves the crop from viral disease infection. Several workers throughout the world recorded the potential of alteration in the date of sowing in various crop plants for the effective management of different viral diseases (Broadbent *et al*., 1952; Brooker, 1963; Tahir *et al*., 2004; Rashid *et al*., 2008; Kone *et al*., 2017). However, widespread use of different methods related to sowing/transplantion for the management of viral disease in different crop plants is lacking. Current study was designed to evaluate the effect of different dates of sowing and methods of planting on the incidence and severity of different viral diseases on muskmelon under field conditions.

MATERIALS AND METHODS

For Nursery raising of the muskmelon two methods i.e. polythene bag and 50 well pro-trays were used. Seeds of variety Punjab Sunheri were sown on 25th December, 5th January, 15th January, 25th January and 5th February in the year 2016-17 and 2017-18. For each date and transplanting/tray transplanting two seeds of Punjab Sunehri variety were sown upto 1.5cm deep per polythene bags/ well of protray on 25th December, 5th January, 15th January, 25th January and 5th February of 2016-17 and 2017-18. After sowing bags/trays were placed in the insect proof polyhouse near the wall facing sunlight. Seedling was maintained as mentioned in Package of practices for cultivation of vegetables, PAU, Ludhiana (Anonymous, 2017). However for direct sowing six seeds per replication were sown on 5th February, 15th February, 25th February, 5th March and 15th March in both the years

Seedling sown on 25th December, 5th January, 15th January, 25th January and 5th February in polythene bags and pro-trays were transplanted at two true leaf stage in the field on 5th February, 15th February, 25th February, 5th March and 15th March, respectively, in the year 2017 and 2018. These seedlings were transplanted in randomized blocks with three replications, for each date of sowing and method of planting. Six plants per replication were maintained in each methods of planting during different dates using agronomic practices recommended by Punjab Agricultural University. Besides above mentioned methods, direct sowing method was also followed for each date of sowing. Six seeds per replication were sown on above mentioned dates of transplanting.

Effect of dates of sowing and methods of planting was recorded sixty days after sowing/transplanting for each treatment.

Among plant health parameter per cent plant survived and per cent disease incidence were recorded. Per cent plant survived was calculated by using following formula:

$$\text{Per cent plant survived} = \frac{\text{Total no. of plants sown or transplanted} - \text{No. of plants survived}}{\text{Total no. of plants sown or transplanted}} \times 100$$

Per cent disease incidence was calculated by the following formula:

$$\text{Per cent disease incidence} = \frac{\text{No. of infected plants}}{\text{Total no. of plants}} \times 100$$

Among yield parameters, total number of fruits per treatment, loss in the number of marketable fruits and loss in the fruit weight were recorded during this study. Total number of fruits from each replication of every treatment was counted and then there mean value was calculated.

Per cent loss in the number of marketable fruits was calculated by following formula:

$$\text{Per cent loss in marketable fruits} = \frac{\text{Marketable fruits on healthy plant} - \text{Marketable fruits on diseased plant}}{\text{Marketable fruits on healthy plant}} \times 100$$

Loss in the fruit weight was calculated by following formula:

$$\text{Per cent loss in fruit weight} = \frac{\text{Weight of fruits from healthy plant} - \text{Weight of fruit from diseased plant}}{\text{Weight of fruits from healthy plant}} \times 100$$

Antisera of some important viruses *viz.* CMV-I, CMV-II and ZYMV were used for serological detection of viral infection in plants sown during different dates with different methods of planting

whereas PALIc and PALIv primer pairs given by Rojas *et al*. (1993) were used for the detection of whitefly transmitted begomovirus infection in muskmelon crop.

Statistical analysis was done by applying analysis of variance in software Windostat Version 9.3.

RESULTS AND DISCUSSION

Effect of dates of sowing and methods of planting on various plant health, growth and yield parameters

Different date of sowing was found to have a significant effect on the health parameters (per cent plant survival and per cent disease incidence) of muskmelon when crop was transplanted/sown through different methods. In case of transplanted crop minimum per cent survival was observed in early transplantation *viz*., on 5th February (88.89%) whereas per cent survival of muskmelon plants during other dates of transplantation was at par with each other (Table 1). In directly sown crop maximum per cent survival was observed in the late sowing of 15th March (100%) followed by 25th February sowing (94.44%). Per cent survival of the plants during 5th March and 5th February was almost at par with each other *viz.,* 77.78% and 75% respectively, however minimum per cent survival of muskmelon plants was observed in crop sown during 15 th February. In tray transplanting maximum per cent survival of plants was observed in 15th February transplanted crop (100%) followed by 25th February and 5th March transplanted crop where same per cent survival of 97.22% was observed. Minimum per cent survival of 88.89% was observed in 5th February transplanted crop. Among different dates of sowing maximum per cent survival was observed in 25th February transplanted or sown crop plants (97.22%) followed by 15th March sown or transplanted crop plants (96.29%) whereas, minimum per cent survival of plants was observed in 5th February sown or transplanted muskmelon crop (84.26%). Transplanting was found to had maximum per cent survival (96.67%) followed by tray transplanting (94.99%) whereas, minimum per cent survival of crop plant was observed in directly sown crop (82.78%) (Table 1).

Per cent disease incidence was found to be minimum in late transplanted crop that was 39.80 per cent in 15th March transplanted crop and 50 per cent in 5th March transplanted crop, whereas maximum per cent disease incidence of 71.90 was observed in 5th February transplanted crop followed by crop transplanted during 15th February (63.90%). In directly sown crop maximum per cent disease incidence (58.40%) was observed in early sown crop (15th February) followed by crop sown on 5th February (55.00%), whereas as least per cent disease incidence was observed in 15th March sown crop (41.70%). Per cent disease incidence in case of 5th March (48.40%) and 25th February (48.80%) sown crop was at par. Similar trend of per cent disease incidence was observed in tray transplanted crop where maximum

Table 1. Effect of different dates of sowing and methods of planting on per cent plant survival and per cent virus disease incidence

	5th Feb	15th Feb	25th Feb	5th Mar	15th Mar	Pooled
Per cent plant survived						
Transplanting	88.89	100.00	100.00	97.22	97.22	96.67
Direct Sowing	75.00	66.67	94.44	77.78	100.00	82.78
Tray Transplant	88.89	100.00	97.22	97.22	91.67	94.99
Gen. Mean	84.26	88.89	97.22	90.74	96.29	
CD (p=0.05)			6.18			
Per cent disease incidence						
Transplanting	71.90	63.90	52.80	50.00	39.80	55.70
Direct Sowing	55.00	58.40	48.80	48.40	41.70	50.40
Tray Transplant	57.90	52.80	53.60	41.80	35.40	48.30
Gen. Mean	61.60	58.40	51.70	46.70	38.96	
CD (p=0.05)			1.6			

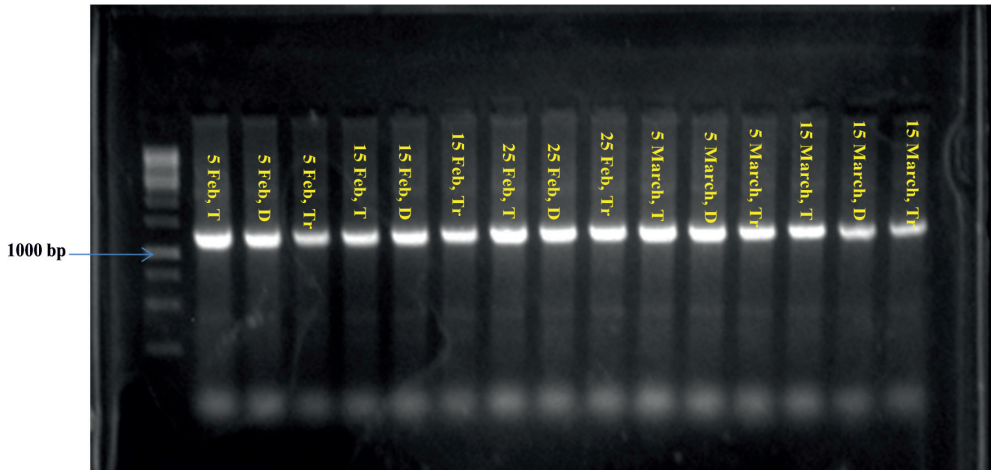

Fig. 1. PCR results in the different dates of sowing and methods of planting with PALIc and PARIv primer pairs. Lane 1 in both the gels contains 1Kb DNA ladder (G-Bioscience)

per cent disease incidence was observed in 5th February (57.90%) transplanted crop followed by crop transplanted on 25th February (53.60%), whereas least per cent disease incidence was observed in 15th March transplanted crop (35.40%) followed by 5th March (41.80%) transplanted crop (Table 1). Among different planting/sowing methods least per cent disease incidence was observed in tray transplanting method with mean per cent disease incidence of 48.30 per cent followed by direct sowing (50.40%), whereas maximum mean per cent disease incidence of 55.70 per cent was observed in transplanting (Table 1).

Several studies found that date of sowing had significant effect on various viral disease incidences. Rashwan (2015) observed that date of sowing had a significant effect on the aphid incidence on muskmelon crop in Egypt. They observed that crop planted during first of March had least incidence of the aphids and hence had least chance to develop any viral disease. Broadbent *et al*. (1952) also observed that early planting of the potato crop had high infection of aphid transmitted potato leaf roll viruses due to the high level of aphid incidence in the early planted crop. Shirshikar (2003) found that there was high incidence of sunflower necrosis disease on the sunflower crop sown early in the month of July and August as compare to the crop sown late in the month of November and December. Rashid *et al*. (2008) also observed that date of planting significantly affects tomato yellow leaf curl virus incidence on tomato crop by affecting the population of whitefly. Brook (1964) observed that the late planting of groundnut also reduces the incidence of groundnut rosette disease in Nigeria. Some workers also found that the late sowing of the crop plant leads to the high incidence of viral disease in different crop plant as Prasad *et al*. (2007) observed that early sown French bean crop of 5th September had lowest incidence of bean common mosaic virus and bean yellow mosaic virus as compared to late sown crop on 20th September. They observed that incidence of bean common mosaic virus was 5 per cent and of bean yellow mosaic virus was 27.93 per cent as compared to 7.3 per cent (bean common mosaic virus) and 28.57 % (bean yellow mosaic virus) in case of 20th September sown crop. Rashid *et al*. (2013) also observed that early sown mungbean crop had less incidence of mungbean yellow mosaic virus as compared to the late sown mungbean crop. Kone *et al*. (2017) observed that date of planting had a significant effect on the susceptibility of different cucumber cultivars to viral diseases at different growth stages.

Average number of fruits 60DAP, per cent loss in the number of marketable fruits and per cent loss in the fruit weight were important parameters that decides actual yield of the crop plants. During this study maximum average number of fruits after 60 days of transplanting was observed in late transplanting of 15th March (23.50) followed by 5th March transplanting (15.00), whereas minimum average number of fruits 60 DAT was observed in the crop transplanted on 15th February (9.33) followed by 5th February transplanting (11.33) (Table 2). During direct sowing, 25th February

Table 2. Effect of different dates of sowing and methods of planting on various average numbers of fruits, per cent loss in the number of marketable fruits and per cent loss in fruit weight

	Average number of fruits (60DAP)					
	5th Feb	15th Feb	25th Feb	5th Mar	15th Mar	Pooled
Transplanting	11.30	9.33	12.50	15.00	23.50	14.33
Direct Sowing	6.17	5.00	12.33	9.17	11.67	8.67
Tray Transplant	9.83	11.00	10.80	9.67	15.00	11.27
Gen. Mean	9.10	8.40	11.90	11.30	16.70	
CD (p=0.05)						1.10
	Per cent loss in number of marketable fruits					
Transplanting	70.58	68.63	60.87	20.56	16.54	47.34
Direct Sowing	71.15	62.86	48.41	41.67	21.26	49.07
Tray Transplant	56.81	53.61	67.17	26.43	24.61	45.72
Gen. Mean	66.18	61.69	58.82	29.55	20.80	
CD (p=0.05)						3.96
	Per cent loss in fruit weight (g)					
Transplanting	57.68	57.89	51.65	23.91	9.91	40.21
Direct Sowing	53.59	48.82	50.02	29.37	16.55	39.67
Tray Transplant	55.15	37.98	44.43	21.51	8.10	33.43
Gen. Mean	55.47	48.23	48.69	24.93	11.52	
CD (p=0.05)						2.69

was found effective with highest average number of fruits 60DAS (12.33) followed by late sowing of 15th March (11.67). Minimum average number of fruits 60 DAS was observed when plants were sown in first fortnight of February *viz*. 15th February (5.00) and 5th February (6.17). In tray transplanting variable trend in the average number of fruits 60DAT was observed, where maximum average number of fruits was noticed in crop transplanted on 15th March (15.00) followed by 15th February transplanting (11.00). Minimum average number of fruits 60 DAT was observed in 5th March transplanted crop (9.67) followed by 5th February transplanting (9.83) (Table 2).

Among different methods of planting maximum mean per cent loss in the number of marketable fruits was observed in case direct sown crop (49.07) followed by transplanting where mean per cent loss in the number of marketable fruits was 47.34 per cent, whereas tray transplanted crop had least mean per cent loss in the number of marketable fruits *viz.* 45.72 per cent. In transplanting per cent loss in the number of marketable fruits was found to be minimum in the late transplanted crop plants *viz.* 15th March (16.54%) followed by 5th March (20.56%), whereas maximum per cent loss in the number of marketable fruits was observed in early transplanted crop *viz.* 5th February (70.58%) followed by 15th February (68.63%) (Table 2). Late sowing of muskmelon also found to be effective with minimum per cent loss in the number of marketable fruits *viz.* 21.26 per cent in case of 15th March sown crop followed by 5th March (41.67%) and 25th February (48.41%). Tray transplanting of muskmelon on 15th March had minimum per cent loss in the number of marketable fruits (24.61%) followed by 5th March (26.43%) however, tray transplanting of the muskmelon on 5th February and 15th February found to have more per cent loss in the number of marketable fruits *viz.* 56.81 per cent and 53.61 per cent respectively. However, maximum per cent loss in the number of marketable fruits (67.17%) was observed in 25th February tray transplanted crop (Table 2).

Along with high per cent disease incidence, early transplanting of muskmelon crop also leads to highest per cent loss in fruit weight viz., 57.89 per cent in 15th February transplanted crop followed by 5th February transplanted crop (57.68%) (Table 2). Minimum per cent loss in the fruit weight was

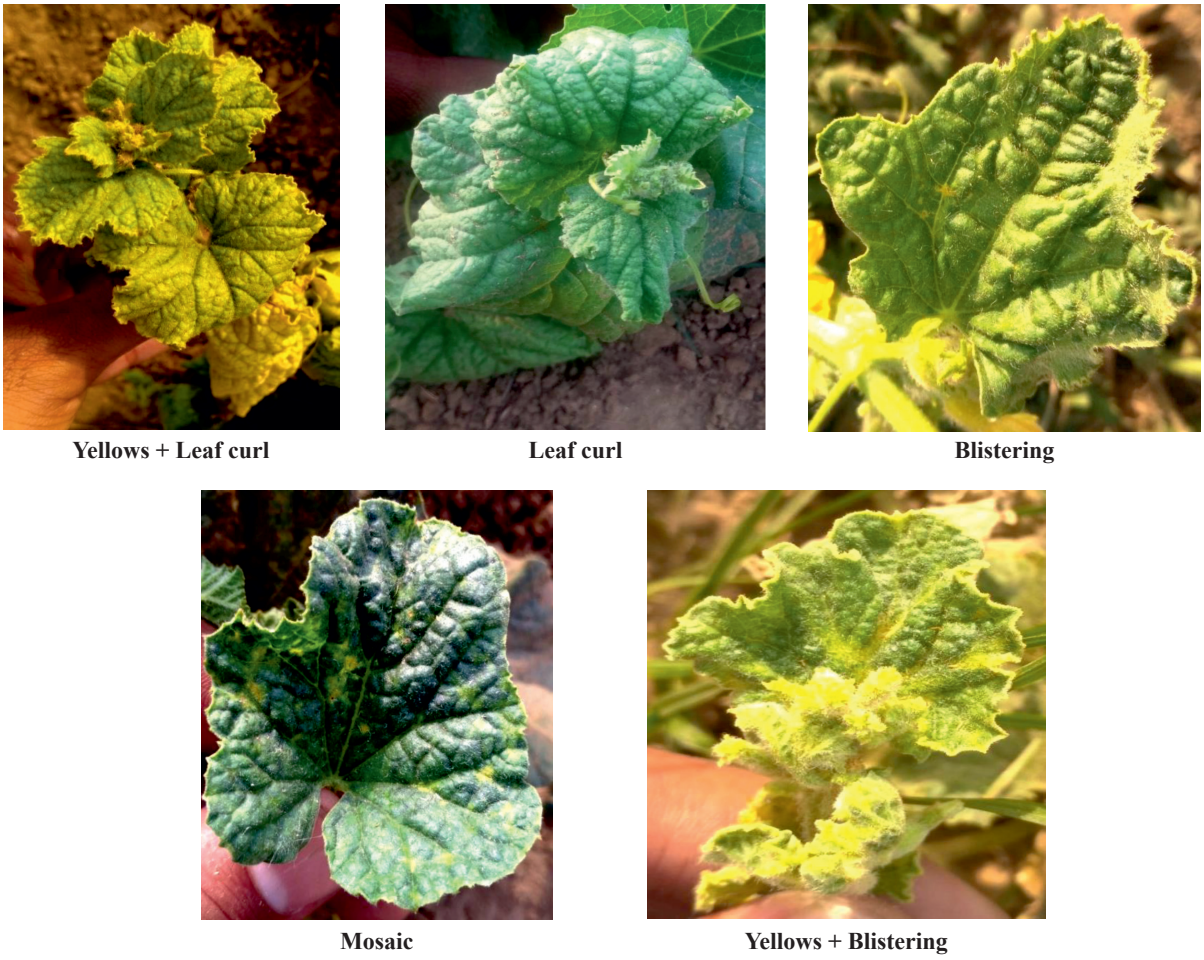

Fig. 2. Different symptoms observed in different date of sowing and methods of planting

observed in 15th March transplanted crop (9.91%) this could be due to the minimum occurrence of the disease on the late transplanted crop (Table 2). Direct sown crop also shows same trend for the per cent loss in fruit weight where, minimum per cent loss in the fruit weight was observed in 15th March sown crop *viz.,* 16.55 per cent followed by the crop sown on 5th March (29.37), whereas maximum per cent loss in the fruit weight was observed in crop sown on 5th February (53.59%) followed by 25th February where per cent loss in fruit weight was 50.02 per cent. In case of tray transplanting maximum per cent loss in fruit weight was observed in 5th February transplanted crop (55.15%) followed by crop transplanted on 25th February (44.43%). However, minimum per cent loss in the fruit weight was observed in tray transplanted crop on 15th March (8.10%) followed by crop transplanted on 5th March (21.51%) (Table 2).

It has also found that sowing date had significant effect on various growth parameters of the crop plants. Rashid *et al*. (2013) observed that in mungbean instead of less disease incidence in the January and February sown mungbean, yield was found to be more in the late sown mungbean crop that was the crop sown in the month of March. Susila *et al*. (2012) sown watermelon crop on four sowing dates (October 4th week, November 2nd week, November 4th week and December 2nd week) and found that the late sown watermelon crop that was sown on December second week had highest fruit yield with maximum number of fruits per plant. Kamali *et al*. (2016) also observed that bitter gourd crop sown in the month May had highest number of fruits per plant *viz.* 5.33 as compared to the 21st January sown crop (3.3). Eifediyi and Remison (2009) also observed that date of planting had significant effect on the yield

Table 3. Impact of different dates of sowing and methods of planting on the occurrence of viral infection

S. No.	Treatments	Symptoms	ZYMV	CMV-I	CMV-II	Begomovirus
1	5 February (Transplanting)	Mosaic + Blistering + Yellows	+	+	-	+
2	5 February (Direct sowing)	Mosaic + Yellows	-	-	-	+
3	5 February (Tray transplanting)	Yellows	-	-	-	+
4	15 February (Transplanting)	Yellows	-	-	-	+
5	15 February (Direct sowing)	Yellows + Mosaic	-	+	-	+
6	15 February (Tray transplanting)	Yellows	-	-	-	+
7	25 February (Transplanting)	Yellows	-	-	-	+
8	25 February (Direct sowing)	Yellows	-	-	-	+
9	25 February (Tray transplanting)	Yellows	-	-	-	+
10	5 March (Transplanting)	Blistering + Yellows	+	-	-	+
11	5 March (Direct sowing)	Yellows	-	-	-	+
12	5 March (Tray transplanting)	Yellows	-	-	-	+
13	15 March (Transplanting)	Yellows	-	-	-	+
14	15 March (Direct sowing)	Yellows	-	-	-	+
15	15 March (Tray transplanting)	Yellows	-	-	-	+

ZYM = Zucchini yellow mosaic virus; CMV-I = Cucumber mosaic virus -I; CMV-II = Cucumber mosaic virus -II

of cucumber. They observed that the early date of planting had highest yield per hectare as compare to the other late planted crop plants.

Different viral pathogens affecting muskmelon crop in Punjab during 2017 and 2018 were found to be ZYMV, CMV and Begomovirus that were detected in infected samples with the help of viral specific antiserum in case of ZYMV and CMV, whereas begomovirus specific primers were used in case of begomovirus infected samples. Begomovirus infection was observed in all treatments, whereas ZYMV infection was observed in 5th February transplanted crop and 5th March transplanted crop however, CMV-I infection was observed in 5th February transplanted and 15th February direct sown crop (Figure 1, Table 3). Yellows, leaf curl, blistering and mosaic were the major symptoms that were observed in different date of sowing and methods of planting (Figure 2).

Therefore it can be inferred that for the Punjab conditions transplanting of muskmelon during 5th March and 15th March was found to be best as the crop transplanted during these dates had least incidence of viral diseases as compared to the early transplanted crop during the month of February. However, among different methods of sowing/transplanting tray transplanting was observed to be effective with less viral disease incidence followed by direct sowing.

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