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Ecofriendly management of mosaic disease of chilli (*Capsicum annuum* L.) with plant products

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Abstract
A field experiment was conducted between the agricultural seasons of 2022 and 2023. Neem (*Azadirachta indica* L.) oil 0.03% 5ml/lit is one of seven plant products. 5% seed kernel extract of neem (*Azadirachta indica* L.) @ 6 ml/lit. 5 ml Karanj (*Pongamia pinnata* L.) oil per lit. Nimbecidine 0.03% at 4 ml/lit, Achook 0.03% at 3ml/lit, Neem gold 0.15% at 2 ml/lit, and Nimastin 0.15% at 2 ml/lit were tested against vector activity to lower the prevalence of mosaic disease. The treatment T_2 with two sprayings of neem seed kernel extract 5% @ 5 ml /lit. at ten-day intervals had the lowest disease incidence (23.45%) and the highest fruit output (64.45 q/ha) during the Rabi, 2022-23 cropping season. Control has the highest disease incidence (35.45%). The mosaic disease of the chilli has a detrimental impact on yield contributing qualities during Rabi season.

Keywords: Chilli, mosaic, management, plant products

Introduction
Chilli (*Capsicum annum* L.) is one of the most important crops among the spices and grown widely around the year. It belongs to the family Solanaceae and genus *Capsicum*. It is a good source of potassium and folic acid and contains more vitamin A and C than carrots and citrus fruits (Howard, 2000; Marin *et al*., 2004) [12, 19]. Among the viral diseases chilli mosaic disease is one of the major diseases. The disease was first reported from India by Kulkarni (1924) [15] and McRae (1924) [15]. The disease was reported to be caused by large number of viruses, out of which, only eight viruses were found in India, of which Pepper vein banding virus (PVBV) and Cucumber mosaic virus (CMV) are the most predominant ones, causing heavy loss in yield (Prasad Rao, 1976; Bidari, 1982; Nagaraju and Reddy, 1983) [24, 21, 3]. Chilli mosaic virus disease under field conditions spread mainly by different aphid vectors. The important vectors which are actively involved in transmission of chilli mosaic disease are *Aphis gossypii*¸ *Aphis craccivora*, *Myzus persicae* (Dubey and Joshi, 1974; Khatri and Sekhon, 1974) [42, 14]. In Uttar Pradesh, the disease occurs at regular intervals in different chilli growing areas resulting in great loss to the crop. The information regarding the status and serological detection of the chilli mosaic virus is very scanty as no work has been done regarding the early detection of the disease by serological mean. So considering all the aspects, the present study was undertaken for the management of the disease through host resistance and bio chemicals.

Materials and Methods
A field trial were done in the experimental compound of the Plant Pathology field, department of Botany, M. L. K. PG. College, Balrampur, U.P., to investigate the efficiency of seven plant products on the incidence of mosaic disease of chilli, fruit production, and yield attributing features. The field trial used the variety G-4 and was conducted in Randomized Block Design (RBD) throughout the Rabi, 2022-23 crop seasons. There were eight different treatments, each with three replications. The plot was 3 m x 1.5 m in size. In the control plots, sterile distilled water was sprayed with each spray. In each plot, the required concentrations of all seven plant components were sprayed twice. The first foliar treatment was done 35 days after transplanting, and the second spraying was applied 10 days later. N: P: K and FYM fertilizer dosages were applied at 100:60:50/ha and 200 q/ha, respectively. The 35-day-old seedlings were transplanted.

The following were the treatment specifics

T_1 - 0.03% neem (*Azadirachta indica* L.) oil @ 5.5 ml/lit, T_3 - Karanj (*Pongamia pinnata* L.) oil @ 4.5 ml/lit, T_2 - neem seed kernel extract 5% @ 6 ml/lit, T_4 - Nimbecidine 0.03% @ 3 ml/lit, T_5 - Achook 0.03% @ 3ml/lit, T_6 - Neem gold 0.15% @ 2 ml/lit, T_7 - Nimastin 0.15% @ 2 ml/lit, T_8 - Control. The total number of plants and diseased plants were counted in each plot to determine disease incidence. Percent disease incidence was calculated by following formula suggested by Nene (1972) [22].

$$\% \text{ disease incidence} = \frac{\text{no.of disease unit}}{\text{total no.of assessed unit}} \times 100$$

Percent disease reduction was calculated by following formula:

$$\% \text{ disease reduction} = \frac{C-T}{c} \times 100$$

Where,

C - Percent disease incidence in untreated plants, T - Percent disease incidence in treated plants. The per cent increase of yield in treatment over control was calculated from the following formula (Vanisree *et al*., 2013) [37].

$$\% \text{ increase of yield in treatment over control} = \frac{\text{yield in treatment - yield in control}}{\text{yield in control}} \times 100$$

Results and Discussion

A lot of diseases harm the chilli crop. The mosaic disease of chilli is the most prevalent of these. During Rabi, 2022-23 cropping season, seven plant products, namely Neem oil, Neem Seed Kernel Extract, Achook, Neem gold, Nimastin, Nibicidine, and Karanj oil, were tested for their impacts on vector activity, disease incidence, and yield contributing features. Commercially, neem products are widely established as botanical pesticides (Gurjar *et al*., 2012) [10]. The data (Table-1) demonstrated that all of the plant items considerably reduce illness incidence when compared to the control. Two sprayings of 6% neem seed kernel extract (T_2) were shown to be the most effective botanical in terms of illness incidence reduction (23.45%). T_2 (neem seed kernel extract 6%) was followed by T_1 (neem oil 0.03%), with an illness incidence of 24.63%. Control had the highest disease incidence (35.45 percent). T_2 (5% neem seed kernel extract), T_1 (0.03% neem oil), and T_4 (0.03% Nimbecidine) were considerably comparable. T_2 had the greatest illness reduction above control (33.86%), followed by T_1 (30.52%) and T_4 (30.19%). During the Rabi cropping season (2022-23), the maximum mean plant height (37.95 cm), mean number of branches per plant (5.30), mean length per fruit (5.99 cm), mean breadth per fruit (0.80 cm), and mean fruit weight per plant (45.05 gm) were recorded in treatment T_2, followed by T_1 (two foliar sprays of Neem oil 0.03%) and T_4 (two foliar sprays of Nimbecidine 0.03%). All therapies were shown to be more effective than control.

Several previous researchers reported similar findings. Rashid and Khan (2000) [27], Harbant *et al*. (1999) [11], and Singh and Sharma (1999) [31] demonstrated the use of botanicals, milk, or cow urine in minimizing insect vectors, reducing viral illness in crops, and increasing yield. Smitha (2002) [41], Varghese (2003) [38], and Gundannavar (2007) [9] have previously reported on the effect of neem products on chilli yield. They reported that neem-based chemicals performed better and are thus superior to RPP in terms of chilli yield. Similarly, Ukey and Saroda (2001) [36] discovered that using neem seed kernel extract alone resulted in increased chilli yield. Similarly, neem derivatives such as neem oil, Comnhoxcomnol Nekhex, Repelin, and orgocide demonstrated their superiority by recording the lowest virus percentage virus transmission and highest percent aphid mortality (Mariappan *et al*., 1993) [18]. Neem seed kernel extract (0.5%) + Nimbecidine (2ml/lit) was found to be the most effective treatment among the various indigenous materials used to control thrips and mites. This combination also produced the highest chilli yield (10.64 q/ha), as well as lower thrips and mite counts (0.4 LCI/plant and 0.7 LCI/plant, respectively).

Mallikarjuna Rao *et al*. (1999) [17] reported on the efficiency of neem oil against chilli thrips. They discovered that 1% neem oil emulsion used as seedling root dip was efficient against *S. dorsalis*, a chilli thrips pest. Neem Gold ® (3%) and NO (3%) were two of the neem products tested in the field that showed promise (Naik *et al*., 2004) [20]. Neem gold (3 ml/l), Vitex (5%) and Clerodendron (5%) were all efficient against yellow mite in chilli, but when used only once, they were outperformed by chemicals (Subba Rao *et al*., 2007) [34].

Chakraborti (2000) [5] found that neem-based pesticides increased the amount of fruits per plant. Bagle (1988) [4], Smitha (2002) [41], Varghese (2003) [38], and Mallapur *et al*. (2001) [16] showed similar results of lowered Leaf Curl Index (LCI) by spraying botanicals, neem products, and indigenous materials in chilli crop. Many workers in India on chilli crop fields have well documented the efficiency of many bio-pesticides in the management of mosaic disease of chilli and controlling of insect pests (Venzon *et al*., 2008; Pandey *et al*., 2010; Elvis *et al*., 2014) [40, 23, 8].

The current study found that two sprayings of neem seed kernel extract 5% @ 5 ml/lit. were the best treatment for checking vector activity of mosaic disease of chilli, resulting in the lowest mosaic disease of chilli incidence (23.45 percent) and the highest fruit yield of 64.45 q/ha during the Rabi 2022-23 crop season than other treatments.

Two sprays of neem oil were the next successful treatment, with a disease incidence of 24.63 percent and a yield of 64.23 q/ha. Neem seed kernel extract reduced disease by 33.86 percent compared to the control, whereas neem oil reduced disease by 30.53 percent. Other researchers had found similar findings in the past. The most effective anti-*Bemisia tabaci* agent was neem seed kernel extract. It was also discovered that neem seed kernel extract possessed both virucidal and insecticidal effects (Singh *et al*., 1988; Raghupathi and Veeraragavathatham, 2002) [31, 25]. This could be owing to the existence of complex insecticidal constituents. Azadiractin is reported to have a variety of impacts on a variety of insect species. Because neem seed kernel extract contains a number of physiologically active components (Alkaloids), it has demonstrated repellency, anti-feedency, anti-growth, and direct toxicity against a variety of insects (Schmutterer, 1990; Chakraborty and Chatterjee, 1999) [28, 6].

The maximum mean plant height, number of branches per plant, fruit length, fruit breadth, and fruit weight were

measured using neem seed kernel extract followed by Neem oil spraying. These phenotypic characteristics were shown to be statistically significant. Khalaequazzawan *et al*. (2016) [13] found a similar conclusion on the influence of bio pesticides on yield contributing features of chilli. They discovered that bio insecticides had a considerable effect on chilli yield and yield contributing characteristics. However, within treatments, plant height was not statistically significant. According to Ahmed *et al*. (2001) [1] neem oil application at 5 ml/l resulted in a 34.28 percent reduction in chilli mite above control. The assessment of botanicals in field conditions revealed that botanicals effectively lower disease resistance when compared to controls. Overall, among the investigated plant products, neem seed kernel extract was shown to be the most effective bio-pesticide against vector activity, followed by neem oil and Nimbecidine, and karan oil was found to be the least effective.

In comparison to the control, all of the studied plant items dramatically reduced vector activity and effectively reduced the mosaic disease of chilli incidence. As a result, the study highly suggests using neem seed kernel extract against vector activities to prevent mosaic disease of chilli.

Table 1: Effect of plants products on mosaic disease of Chilli incidence and green fruit yield Rabi, 2022-23 cropping season

Treatments	Dose (ml/lit)	Mosaic disease incidence (%)	Disease reduction over control (%)	Yield (q/ha)	Increase yield over control (%)
T_1 – Neem oil 0.03%	5	24.63 (31.90)**	30.53	64.23	33.82
T_2 – neem seed kernel extract 5%	6	23.45 (30.05)	33.86	64.45	34.28
T_3 – Karanj oil 0.15%	5	32.90 (35.99)	7.20	50.67	5.56
T_4 - Nimbecidine 0.03%	4	24.75 (29.80)	30.19	63.34	31.96
T_5 - Achook 0.03%	3	26.89 (30.73)	24.15	61.12	27.34
T_6 - Neem gold 0.15%	2	26.96 (31.20)	23.95	58.23	21.31
T_7 - Nimastin 0.15%	2	30.24 (33.30)	14.70	53.12	10.67
T_8 – Control		35.45 (37.10)		48.00	
S.Em ±		1. 54		0.172	
C.D. at 5%		4.70		0.53	
C.V. %		8.86		11.41	

Table 2: Effect of plant product on yield attributing characters of chilli Rabi, 2022-23 cropping season

Treatments	Dose (ml/lit)	Mean plant height (cm)	Mean no. of branches/plant (No.)	Mean length/ fruit (cm)	Mean breadth/ fruit (cm)	Mean fruit Weight/plant (gm)
T_1 – Neem oil 0.03%	3	36.90	5.10.	5.70	0.78	44.28
T_2 – neem seed kernel extract 5%	5	37.95	5.30	5.99	0.80	45.05
T_3 – Karanj oil 0.15%	5	32.58	3.66	4.50	0.62	37.25
T_4 - Nimbecidine 0.03%	5	36.66	5.00	5.40	0.77	43.75
T_5 - Achook 0.03%	3	36.55	4.55	5.25	0.75	42.75
T_6 - Neem gold 0.15%	2	35.53	4.24	5.10	0.67	41.33
T_7 - Nimastin 0.15%	2	33.92	4.12	4.50	0.63	38.50
T8 – Control		30.02	3.38	4.00	0.50	33.20
S.Em ±		1.66	0.36	0.38	0.06	2.36
C.D. at 5%		5.09	1.13	1.19	0.16	7.25
C.V. %		8.19	14.43	13.01	14.89	10.06

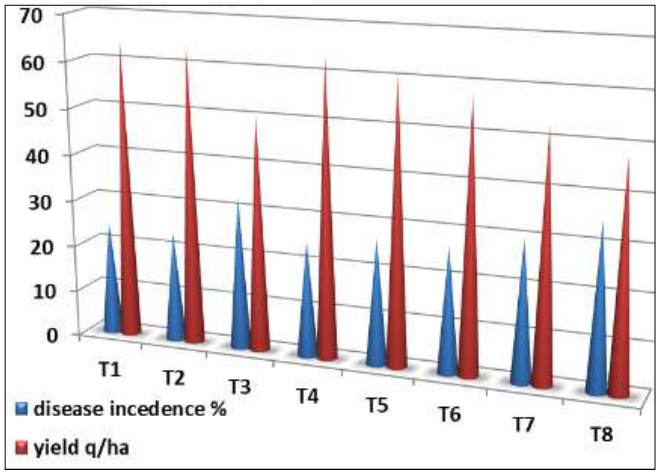

Fig 1: Effect of plant products on mosaic disease of chilli incidence and fruit yield of chilli during Rabi, 2022-23 cropping season

Conclusion

The study effectively evaluated several botanicals for their efficacy in managing mosaic disease of chilli during the Rabi season of 2022-23. Neem-based treatments, particularly neem seed kernel extract at 6% concentration, emerged as the most promising bio-pesticide, significantly reducing disease incidence by 33.86% and enhancing yield by 34.28% compared to the control. Neem oil at 0.03% also demonstrated substantial disease reduction (30.53%) and yield improvement (33.82%). These findings are consistent with previous research highlighting the effectiveness of neem derivatives in disease management and yield enhancement in chilli crops. The study underscores the practical viability of botanical pesticides like neem products in sustainable agricultural practices, offering farmers an eco-friendly alternative to synthetic chemicals for crop protection and productivity improvement.

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