REJUVENATION OF VIRUS AFFECTED BLACK PEPPER PLANTATIONS THROUGH SOIL AND PLANT HEALTH MANAGEMENT

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Black pepper (*Piper nigrum* L), the ' King of Spices' is widely cultivated in 26 countries located in the tropical and subtropical regions of the world. The cropped area under black pepper in the world is about 4.66 lakh ha with a production of 4.57 lakh tons during 2013 (FAO Stat). India has the largest area under black pepper (1.29 lakh ha) with a production of 55,000 tonnes. Low productivity of the crop in India as compared to other competing countries is mainly to related presence of aged or senile vines, less intensive cultivation with low levels of input supply and crop loss due to pests and diseases. Viral disease is one of the serious and emerging constraint in all black pepper growing countries of South East Asia and Brazil. In India, a disease incidence ranging from 0-100% in different plantations is observed. In India, the incidence of the disease was highest in Wayanad and Idukki Districts in Kerala followed by Kodagu and Hassan Districts in Karnataka. The disease severity is observed to be more during summer months especially in poorly nourished plantations. Yield loss due to the disease may vary from negligible loss to 85%. All the existing cultivars and improved varieties including hybrids are susceptible to the disease under natural conditions.

Diagnostic symptoms and causal virus

The major virus associated with the disease is known as *Piper yellow mottle virus* (PYMoV) (a double stranded DNA virus belonging the genus, *Badnavirus* of the family, Caulimoviridae). The virus is transmitted through vegetative means (stem cuttings from infected plants carry the virus). In addition, mealybugs can also transmit the virus from diseased plant to healthy plants in the field.

A wide range of symptoms are observed on infected vines under field conditions. Mosaic, mottling, leaf deformation, stunting of whole plant are the most visible symptoms in the field (Fig. 1). The initial symptoms of the disease include chlorotic specks, vein clearing, mosaic and yellow mottling. In severe cases, the leaves become abnormally narrow and appear sickle shaped. The internodes of vines become abnormally short leading to stunting of plants. Sometimes depending on the season, growth stage and other factors, the disease affected plants do not produce any visible external symptoms. This kind of masking of symptoms in certain affected plants may be seen during monsoon and winter months while symptoms are best exhibited during summer months.

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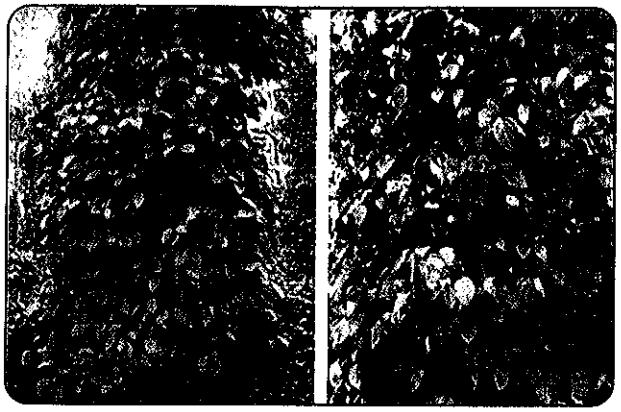
Thus, plants that do not show symptoms cannot be always considered as virus-free. Laboratory based methods such as polymerase chain reaction (PCR) is required to confirm the presence or absence of virus in the plant.

Fig 1. Symptoms of viral disease affected black pepper

Management of virus affected black pepper plants

Viruses are systemic in nature, *i.e.*, once they infect a plant they remain in the plant system throughout its life. They cannot be eradicated by chemicals as there are no effective viricides that can kill viruses. Viruses, being obligate parasites, require living plants for their survival. Hence in most cases viruses do not kill their host plants suddenly, they use host machinery for their own replication thus reducing vigour and ultimately reducing yield. Our studies have clearly showed that symptom severity of the virus affected black pepper was more when the plants are subjected abiotic stress such as temperature and nutrients.

Black Pepper being perennial in nature uprooting and removal of virus infected plants is not a good solution as virus infected plants continue to yield. In view of this, ICAR-Indian Institute of Spices Research, Kozhikode, Kerala has developed a package to rejuvenate the virus infected plants and to sustain the yield by maintaining good soil and plant health with site specific nutrient application.



(a) (b)

Fig. 2. Virus infected black pepper plants showing mild (a) and moderate (b) symptoms

Studies across pepper growing districts of Kerala in different cropping systems showed an alarming trend of nutrient imbalance. Soils were generally acidic with >54% of samples falling below 5.5 pH. The mean available P level was above 25 kg/ha and more than 60% of the soils had very high (36-100 kg ha^{-1}) available P. The exchangeable K levels were low-medium in 70% of soils, exchangeable Ca was low in 40%, exchangeable Mg in 75% of the samples and B in 59% samples. In the case of Karnataka, the soils of major black pepper growing tracts (Uttara Kannada, Hassan, Chikkmagalur, Shimoga, Kodagu districts) are acidic, high in organic carbon content, medium to sufficiently high in available P, low to medium in K, and just above critical limits in soil available Zn and B. Relatively excess/ indiscriminate and long term use of N & P straight fertilizers, which are generally free from micronutrients, ignoring potential soil amelioration with liming materials, has raised serious concern about preferential building up of P and imbalance of other

nutrients, and created wide spread deficiencies of secondary and micronutrients especially Mg, B and Zn in major pepper growing soils. The alleviation of such deficiency by use of corrective soil amendments and micronutrient fertilizers is also limited due to non-availability of standard fertilizer materials and its awareness by farmers.

In view of the above, we conducted trials for the management of virus in farmer's field at various locations in Karnataka for three years, where individual plants in a plantation were graded initially as mild and moderately affected vines based on visual symptoms. Initially existing soil nutrient status of these selected fields were done. Each grade was applied with treatments that contained combinations of FYM, site specific nutrient NPK application, foliar micronutrient supplementation and PGPR to boost the health of the plantations to sustain their health and there by yield. Three years results showed that the combined application of manure, nutrients and PGPR boosted the health of both mild and moderately virus infected vines significantly. This combined application resulted in more number of leaves, well developed canopy and spike intensity per unit area and fresh yield (30-50% higher) in virus infected vines as compared to control. The health status of the vines also scored high, 2.9-3.2 (on the scale of 1-5 from severely infected to very healthy based on visual scoring) under both categories showing improved health of the vines with very few yellow specks on the leaves, thus masking the virus symptoms.

Improvement of the health and canopy status was better in mildly infected vines than severely affected vines. Canopy development by the production of new leaves was also higher under the mild category vines as compared to the moderate category. The canopy build up was also significantly higher in all the treatments applied with FYM, NPK, PGPR and micronutrients as compared to control as these supplementations improved the health and helped in production of new leaves to build the canopy in all the locations studied. The combined application of FYM, nutrients and PGPR had more influence on the vine health status and the canopy size development than individual application. The fresh yield was higher in application of FYM + NPK + PGPR + Micronutrients (3.6-7.1 kg/std) that was significantly higher than control (2.4-4.4 kg/std) across estates.

In general, as long as the vines are yielding farmers may not be willing to sacrifice the vines even if they are infected by virus especially when the crop is fetching higher price in the market. Hence farmers need to be educated about the symptoms and management of the disease. As the disease spread is primarily through planting materials, adequate care should also be taken to plant healthy virus- free cuttings especially in new areas where the incidence of the disease is not observed in the field.

The infection in plants may vary from apparently healthy, mild, moderate and severe. Our study clearly showed the mild and moderately infected plants can be revived. Severely infected plants show severe deformation of leaf, reduction in leaf size and internodal length leading to severe stunting of plants and poor yield. It is uneconomical to retain such severely infected plants; they should

be removed and burnt or buried deep in soil. Farmers should avoid taking runners/ cuttings from the virus infected plants for further multiplication and planting.

To revive and sustain the health and yield of the mild/ moderately virus infected plants we recommend the following package:

* Correct the soil acidity by application of amendments like lime or dolomite, based on the soil test
* Apply FYM - 10-15 kg per standard
* Apply site specific NPK application based on the soil test
* Apply black pepper specific PGPR consortia & Trichoderma, twice (June & Sept) either by fortifying with FYM (and applied 10-15 kg) or as drenching (2-3 L per standard).
* Apply micronutrient (IISR Black pepper special) as spray on leaves @ 5g/L twice, after spike emergence during May-June and after spike setting during August-September.

Not only the individual nutrient supply or concentration in soil or leaf, but the combined effect of each nutrient and its balanced supply matters proper uptake and its utilization. Hence, location/ site specific crop management programs should form the basis for balanced nutrient application and need based foliar supplementations for sustaining the health and yield of the black pepper plants.

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