

Eco-friendly crop health management for organic farming

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Organic plant health management aims at sustainable agriculture, enhanced biodiversity, food safety and security, and clean environment with no use of chemical pesticides. The task mandates knowledge based integrated management of insect pests, diseases, weeds, and other pests. High quality seed with early seedling vigour has the distinct advantage in fighting against weeds, diseases and insect pests. Summer ploughing is useful in killing the propagules of problematic weeds, hibernating pupae of insects, and pathogens. Intercropping wards off many pest and diseases and reduces weed menace. Rice blast is successfully managed using host plant resistance and interplanting of disease resistant varieties with the susceptible ones. 'No early spray' promotes natural enemies. Healthy seeds manage diseases successfully. Skip row planting is useful in containing pests and diseases. Cropping system and crop diversification involving suitable crops manages pests and diseases. Soil borne pathogens can be effectively controlled by growing non-host crops and using compost and vermicompost.

Keywords: Cropping, Insect pests, Organic, Sustainable, Weed

During 'Green Revolution', use of high-yielding varieties, chemical fertilizers and irrigation water promoted plant growth with succulent tissues, making the crop plants more susceptible to insect pests, diseases and weeds. Pest management using chemical pesticides became an integral part of green revolution to ensure food security. However, their continuous application is causing environmental pollution, resurgence of insect pests, and development of resistant strains. Also, there is loss in biodiversity and adverse effect on non-target species. It is estimated that global insect population has fallen by over 50%. Over 98% of sprayed insecticides and 95% of herbicides have impacts on non-target species, air, water and soil. All these have adverse impact on soil, plant, animal and human health. Poor quality of food, water, soil and air under chemical intensive farming is ultimately affecting the

human health. Adverse effects of long term use of pesticides include dysfunctions in neurological, hormonal, and immune system, and cancers in humans. This has increased the medical and economic burden, human sufferings and poor physical and economic efficiency.

Considering such demerits of chemical farming, there is renewed interest for promoting organic farming. The plant health management should exploit cultural, physical and biological aspects in pest management for enhanced biodiversity, food safety and security, human health and economic prosperity. This article concisely describes such aspects.

Disease management

Crop rotation and diversification: In a field trial in the year 2022, it was observed that bacterial wilt in tomato was minimal in plots in which millet-tomato cropping system was

followed as compared to brinjal-tomato sequence. The beneficial effect of cropping system involving marigold (*Tagetes* spp.) in managing dreaded soil borne nematodes has also been reported. Continuous cultivation of soybean as a profitable crop in Vertisols of Central India invited yellow vein mosaic problem. The problem could be contained by crop diversification using millets or maize. Soil borne pathogens like *Fusarium* and *Rhizoctonia* can be effectively controlled by growing non-host crops in rotation.

Compost and vermicompost: Compost and vermicompost are useful in managing soil borne pathogens. In an experiment in summer 2023, dry direct seeded rice was infested with fusarium wilt. In the pot study, vermicompost application at 5 t/ha at early stage, and in the field study, application of *Trichoderma viride* inoculated compost at 5 t/ha could effectively

manage the disease. Vermicompost application is useful in maintaining the beneficial microbe population and reducing harmful pathogens.

Sowing time: Sowing time is important in improving crop health and reducing pathogen load and/or virulence phase, with no additional cost. Yellow vein mosaic is a difficult-to-control disease in legumes such as green gram, black gram, soybean and cowpea. Integrated disease management involving sowing time, variety, rogueing and vector control in early stage proves useful in containing diseases. Severity of sheath blight disease in rice is reported to be less in early sown crop.

Mulching: Mulching with dried water hyacinth improved tuber yield of potato by 3.02 t/ha from 11.36 t/ha as compared to the no mulching. The proportion of large sized tuber yield was higher (60%) under mulching in comparison to no-mulching control (51%). In 2005-06, low yield of 0.5 t/ha under no-mulching as compared to 2.3 t/ha under mulching were due to the severity of bacterial wilt followed by late blight. Incidences of both the diseases were less severe under mulching.

Tolerant variety: Use of tolerant potato variety Kufri Megha and adoption of mulching was effective to reduce wilt and blight incidence and also to increase tuber yield in potato. Tolerant varieties of crop plants are available and can be effectively utilized in disease management. Use of host plant resistance against rice blast is a success in Arab Republic of Egypt.

Planting geometry: Changing rice planting geometry by skipping one row after three rows with 15 × 15 cm spacing resulted in higher grain yield with a reduced incidence of sheath rot disease (34.4%) and also its severity in terms of chaff number per panicle (41.4). Grain yields were similar with the planting geometry of 20 × 15 cm (recommended practice in *kharif* season). Skip row planting is also useful in containing sheath blight disease in paddy for which host to host contact is necessary. Blast disease in rice can be mitigated through interplanting of disease

resistant high yielding varieties with susceptible ones, a practice widely adopted in China.

High quality seeds: High quality seed stock with early seedling vigour has the distinct advantage in fighting against weeds, diseases and insect pests. Seed health campaign in Bangladesh is a success story in disease management. Good quality planting material in potato is effective against many diseases.

Clean culture: Clean field bunds and fields help in reducing pathogen multiplication by minimizing the contact with alternate hosts and collateral hosts. Rice blasts and false smut incidence were minimized by practicing clean culture.

Summer ploughing: The practice helps in disrupting life cycles of pathogens and creating unfavourable conditions for their growth. Summer ploughing improves aeration which in turn creates a more favourable environment for beneficial soil microorganisms.

Insect pest management

Sowing/planting time: Early or late sowing of paddy attracts stink bug population. This is because most of the timely sown fields are not in flowering stage as compared to the fields with very early and late planting. So, the pest mass is attracted and concentrated in a limited area causing more damage. Likewise, late sowing or planting of rice invites stem borer population from other fields.

Planting geometry: Hopper burn caused by brown hoppers in paddy can be managed by modifying the planting geometry. After transplanting 8 to 10 rows, one row is skipped. This permits enough sunlight into the field interfering with the pest activity and multiplication.

'No early spray': 'No early spray' against any likely insect pest infestation often boosts the population of the natural predators and parasites which control the target insect pests. Also, little damage caused is recovered easily due to high recouping capacity of rice plant in early growth stage.

Crop diversification and

intercropping: Intercropping upland rice with pigeon pea and sorghum with groundnut wards off many pests and diseases in addition to complimentary reaction between legumes and cereals. In crop rotation, inclusion of deep rooted crop like alfa-alfa or pigeon pea, not only catch the nutrients like nitrogen and potassium escaping to the subsoil, but also loosen the hard pan in subsoil (bio-tillage) and reduce the risk of pest resurgence, disease out-break and weed severity. Intercropping of wheat with mustard reduces aphid and disease incidence. Similarly, intercropping of wheat with chickpea is useful in low wilt incidence in the latter and weed problem with the former. The system is also useful in efficient N-fixation.

Indigenous technical knowledge (ITK): The stink bugs are active on rice panicle at milking stage when use of chemicals is harmful. ITK is effective in managing this pest by placing traps made of rotten crabs or eels. Dead eels or crabs (after breaking the shell) are hung in rice field with bamboo sticks. Stink bugs are attracted by the rotten smell of these trapping materials making it easy to kill the pest mechanically with a net or by fire.

Rice based farming system: Growing of a single crop in large patches over seasons leads to erosion in biodiversity and the risk of pest outbreak. Farming system involving several crops and other enterprises like dairy, poultry, piggy, fishery, apiary etc. in a complementary manner utilize farm resources optimally and efficiently. The choice of farm enterprises is decided depending on the socio-cultural value and local needs. Rice-fish based farming system in South-East Asian countries is a glaring example in managing several insect pests and weeds in rice. Recycling of animal wastes and crop residues as compost or vermicompost and their soil application enhances beneficial earthworms and microbial load. Co-existence of complementary enterprises helps in maintaining biodiversity and bio-control of insect pests, diseases and weeds.

Summer ploughing: It is useful in killing hibernating pupae of stem borer and other insects by the desiccating effect of sunlight and high temperature. Also, soil inhabiting insects are exposed during plough and predatory birds following the plough prey upon them.

Weed Management

Critical period: Allowing weeds for initial one or two weeks help in pooling up mobile nutrients and encouraging biodiversity. For most crops, the critical period varies between 15 to 45 days after sowing/planting. Weeds may be allowed to grow even beyond this period till there is no adverse effect on crop growth and yield.

Allelopathy: It is one form of interference that occurs when a plant, through its living or decaying tissue, interferes with growth of a weed. Some plants actively eliminate competition by producing toxins that enter the soil and prevent the normal growth of other plants. Corn cockle and ryegrass seeds fail to germinate in the presence of beet seeds. *Cyperus rotundus*, a notorious weed, can be managed by including *Sesamum indicum* in crop rotation for some years.

Summer ploughing: It is useful in exposing and desiccating the propagules and roots of problematic weeds. This creates an interruption in the life cycle of weeds.

Cover crop: Growing of *Sesbania* as cover-cum-green manure crop and its incorporation one week before transplanting in lowland rice in Asia and Africa proved useful in adding up to 100 kg N/ha, and reducing weed problem to

a great extent. Cover crop takes care of summer weeds and then the transplanted paddy easily smoothers the subsequent weed flush.

Transplanting and double transplanting: Weed pressure is very high in irrigated paddy and also, in favourable shallow lowlands due to favourable growing conditions. Thus, puddling and transplantation method is followed to manage weeds and water. Double transplanting is followed in flood prone lowlands, and also, in *boro* rice to overcome the problem of low temperature stress, especially in undulating fields.

Intercropping: Intercropping of rice with pigeon pea, sorghum or maize with groundnut, soybean with pigeon pea, and wheat with mustard or chickpea reduces weed growth. Also, intensity of weeds such as *Phalaris minor* in wheat and *Echinichloa* spp. in rice is less under intercropping. Legumes grown as intercrop have smothering effect on weeds.

Placement of fertilizer: Band placement of fertilizers is advantageous to crops. Thus, placement of urea super granules in reduced zone proves disadvantageous for shallow rooted weeds such as *Fimbristylis* and *Cyperus iria*, *Cyperus difformis* etc.

Placement of irrigation water: Drip irrigation precisely recharges water in the root zone while the bulk of the field remains dry. This helps in saving water and reducing weed, insect pest and pathogen load.

Mulching: Mulching is very effective in controlling weeds. Dried water hyacinth, paddy straw and stubbles, and other such wastes are effective in checking evaporation

loss, moderating soil temperature and significantly managing weeds. However, in soils with termite and rat problem, decomposed organic materials should be used as mulch to avoid the two pests.

Suitable cropping system: In maize cultivation, velvet bean as the preceding crop proves very useful in increasing cob yields by providing up to 150 kg N and 35 t fresh organic matter/ha, reducing labour requirement for weeding by 75% and eliminating herbicide use.

SUMMARY

Many non-chemical eco-friendly practices are effective in managing plant health by controlling pathogens, insect pests and weeds. These environmentally safe practices are the need of the hour, when the environment is getting increasingly contaminated with a wide range of obnoxious chemicals. The added advantage is that biodiversity and natural biocontrol agents are not only protected, but promoted too. Some of them such as timely sowing, variety selection, and use of healthy seeds do not incur any additional cost. Adequate planning, strengthening knowledge base and awareness, use of digital tools, cooperative approach by the community, accounting environmental benefits and ecosystem services, institutional innovations, and supportive policies shall surely help in encouraging eco-friendly practices for pest management in much needed organic farming.

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