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IDIPM Schedule: Key to Manage the Bacterial Blight Disease in Pomegranate

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Abstract

The ICAR-National Research Centre on Pomegranate, Solapur formulated 'Integrated disease and insect-pest management (IDIPM) schedule comprising of (i) avoiding rainy season crop for 2 years, (ii) balanced plant nutrition, (iii) orchard sanitation, (iv) use of bactericides with compatible fungicides and insecticides and (v) bio-formulations and elicitor molecules that trigger systemic acquired resistance in plants for mitigating the losses caused by bacterial blight disease in pomegranate through expert consultation. The schedule was validated in farmers' orchards spanning over diverse agro-eco-regions in the state of Maharashtra, Karnataka and Andhra Pradesh. Bacterial blight was managed successfully (86.04% reduction) with conspicuous improvement in yield (yield increased up to 79.5%). This resulted in average cost-benefit ratio of 1:4.19 and reduction in number of chemical sprays. The IDIPM schedule has become the life line of pomegranate growers. The reproducibility of the technology can be evidenced from consistent increase in national pomegranate productivity ranging from to 6.9 t ha^{-1} in the year 2011-12 to 11.67 t ha^{-1} in the year 2016-17 (69.13% increase).

Background Information

Pomegranate (*Punica granatum* L.), an economically important fruit crop is drawing a great attention to the people world-over because of its immense nutraceutical value and multipurpose uses (leather, dye and pharmaceutical industry). This crop is adaptable to diverse climate, soil and water condition and more specifically it is tolerant to drought. Therefore, this is an excellent choice under arid and semi-arid condition and is most suitable for replacing subsistence farming and bringing prosperity in arid and semi-arid regions. In addition, it provides nutritional security and has potentials to develop waste lands widely available in the arid and semi-arid regions of India and is an ideal crop for diversification. Moreover, it can make higher contribution to GDP with small area.

India is one of the leading countries in pomegranate acreage and production worldwide. The area under cultivation of pomegranate has grown up by 35.19 percent during the last decade, as area increased from 96.9 thousand hectares (2003-04) to 262 thousand hectares (2018-19). At present, Maharashtra with an area of 147.91 thousand ha is the leading state in acreage and accounts for 56.45 percent of the total area under pomegranate in the country. Other major pomegranate growing states are Gujarat (30.51 thousand ha), Karnataka (25.97 thousand ha), and Andhra Pradesh (9.47 thousand ha), Madhya Pradesh (9.23 thousand ha), Rajasthan (4.44 thousand ha).

But in the recent-past, major pomegranate growing states viz. Maharashtra, Karnataka and Andhra Pradesh were facing great losses due to wide spread incidence of bacterial blight

Crop: Pomegranate (*Punica granatum L.*)
Variety: Bhagawa
Name of the Farmer(s) and Address: Mr. Subhash Dongare, Hiraj, Solapur, Maharashtra

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disease in pomegranate resulting from intensification of cultivation practices under changing climatic scenario.

Institutional Intervention

In order to mitigate this huge losses, an orchard health management schedule was formulated by the pomegranate research workers all over India at a high-level meeting under the chairmanship of Deputy Director General (DDG), ICAR, New Delhi in February, 2007 and the schedule was validated in 2007-08 at farmer's field with the successful harvest of 16 tonne disease-free yield form 1 ha area. Subsequently, the same schedule was demonstrated in a network mode project in Maharashtra, Karnataka and Andhra Pradesh. The schedule was successfully demonstrated in 28 blight affected orchards with reduction of blight severity by 67.49% in the first year and 73.97% in the second year. This IDIPM schedule include following operations.

Selection of Bahar

In infected orchard, hasta bahar crop is advocated. Flowering generally takes place in September-October and subsequent fruit setting and development do not encounter with humid climate, hence bacterial blight causing pathogen does not spread rapidly unless there happens to be unseasonal rain.

Sanitation Measures

Diseased twigs and infected fruits are removed with secateurs sterilized with sodium hypochlorite (2.5%) and brunt outside the orchard. Infected dried leaves, flowers, fruits and twigs lying on the orchard floor and irrigation channel are collected and put into composting pit.

Nutrient Management

After the harvest of previous crop leaf nutrient status are appraised with leaf nutrient norms developed for making plant moderately resistant against bacterial blight disease. If a particular nutrient status fall within the optimum range only recommended fertilizer dose is required to be applied. If the nutrient status is below the optimum range, fertilizer dose to be increased by 25% and if above the optimum range, fertilizer dose is required to be reduced by 25%.

Table 1: Manures and fertilizers are applied in three splits as mentioned below

During rest period (After harvest of previous crop)	During fruit setting (0-60 days after flowering)	During fruit maturity (120-180 days after flowering)
Farm yard manure: 20-30 kg/plant (depending on age of plant	Farm yard manure: 20-30 kg/plant (depending on age of plant	Nitrogen (N): 260 g/plant preferably in the form of urea N (N 46%)
Nitrogen (N): 280 g/plant preferably in the form of urea (N 46%)	Nitrogen (N): 95 g/plant preferably in the form of ammonical N (N 21%)	Phosphorus (P2O5): 120 g/plant in the form of MPP (0-52-34)
Phosphorus (P2O5): 65 g/plant in the form of single super phosphate (P2O5 16%)	Phosphorus (P2O5): 65 g/plant in the form of DAP (P2O5 46%)	Potassium (K2O): 182 g/plant in the form of sulfate of potash (K2O 50%)
Potassium (K2O): 203 g/plant in the form of murate of potash (K2O 60%)	Potassium (K2O): 115 g/plant in the form of sulfate of potash (K2O 50%)	Calcium (Ca): 112 g/plant in the form of calcium nitrate (Ca18%).
Calcium (Ca): 488 g/plant in the form of gypsum (Ca 16-19%).	Calcium (Ca): 200 g/plant in the form of gypsum (Ca 16-19%).	Magnesium (Mg): 40 g/plant in the form of magnesium sulphate (Mg 10%)
Magnesium (Mg): 80 g/plant in the form of magnesium sulphate (Mg 10%)	Magnesium (Mg): 30 g/plant in the form of magnesium sulphate (Mg 10%)	
	Foliar sprays of zinc sulphate @ 0.3%, manganese sulphate @ 0.6% and boric acid @ 0.25% are applied three times one at flowering and other two at 30 and 60 days after flowering.	
All fertilizer materials are mixed well with well decomposed FYM and are applied in the root zone (below drippers). Light irrigation should be provided immediately after fertilizer application.		
Bio-formulation like N2 fixer, phosphate and potash *solubilizer, Aspergillus niger* and *Pseudomonas fluorescens* are inoculated @ 50 g /plant with well decomposed FYM and applied in the root zone 15-20 days after fertilizer application.		

Cultural Practices and Plant Protection Measures during Rest Period

After previous crop, infected branches, twigs are pruned and infected fruits are removed from the plant. As the rest period of hasta bahar crop coincided with the rainy season, Bordeaux paste (10%) should be applied on the pruned end of stem to prevent further entry of pathogen through cut end. Besides, Bordeaux mixture (1%), streptocycline (@ 0.5 g/lit) along with copper oxychloride (@ 2.5 g/lit) and bronopol (@ 0.5 g/lit) along with captan (@ 3 g/lit) are required to be sprayed alternately at 15 days interval. After three months of rest period, irrigation is totally withheld for a period of 30-45 days to impose stress in plant.

Prunning and Bahar Regulation

Towards the end of stress period, plants are pruned to remove old branches, cris-cross branches and infected branches (at 2 inches below the infected area) to open up the centre for proper light and air penetration. Bacterial blight cankers are scooped out and pasted with Bordeaux paste (10%). Half pencil thickness (*i.e.* 0.25-0.30 cm thick) and refill thickness branches are pruned at 5 to 8 cm from the top all around the plant to promote axillary bud formation for flowering. Bordeaux paste (10%) is applied on the cut ends after pruning and a foliar spray of bordeaux mixture (1%) is undertaken immediately after pruning. Once pruning is over, ethrel 39% SC is sprayed @ 2.0-2.5 ml/l along with DAP 5 g/l for defoliating pomegranate plant. Within a week all plants get defoliated to the extent of 70-80 %. Fallen leaves are collected and put into the composting pit for maintaining good sanitation. Bleaching powder is dusted @ 100-150 g/plant on the ground below the canopy.

Triggering Plant's Defense Mechanism

Spraying of salicylic acid @ 300 ppm three times after fruit set at 20-30 days interval are advocated to improve plants' systemic acquired resistance against bacterial blight diseases.

Plant Protection Measures

The following spray schedule was adopted in demonstration plots for management of bacterial blight disease.

Table 2: Spray schedule of pesticides for management of diseases and pests in pomegranate

Spray schedule	Time of spray	Plant protection chemicals sprayed
1st	Immediately after prunning	Bordeaux mixture (1%)
2nd	Seven days after 1st spray	*Pseudomonas fluorescens* talc based formulation @ 2 g/lit. with continuous agitation
3rd	Eight days after 2nd spray (When new flush come out)	Sprayed Thiamethoxam 25 WG @ 0.3 g/lit. for management of sucking pest. Copper oxychloride 50 WP (2.5 g/lit) + Bronopol (0.5 g/lit) along with spreader sticker.
4th	Fifteen days after 3rd spray (at flower bud initiation)	Streptocycline (0.5 g/lit.) + Carbendazim 50 WP (1.0 g/lit) + Acetamiprid 20 SP (0.3 g/lit) along with spreader sticker.
5th	Fifteen days after 4th spray	Captan 50 WP (2.5 g/lit.) + Bronopol (0.5 g/lit.) + Imidacloprid 17.8 SL (0.3 ml/lit.) along with spreader sticker.
6th	Fifteen days after 5th spray (at initiation of fruit setting)	Streptocycline (0.5 g/lit.) + Thiophanate methyl 70 WP (1.0 g/lit.) + Cypermethrin 25% EC (1 ml/lit.) along with spreader sticker.
7th	Seven days after 6th spray	*Pseudomonas fluorescens* talc based formulation @ 2 g/lit. with continuous agitation
8th	Seven days after 7th spray	Bordeaux mixture (0.5%)
9th	Fifteen days after 8th spray (at 50% fruit setting)	Streptocycline (0.5 g/lit.) + carbendazim 50 WP (1.0 g/lit.) + Chloropyriphos 20% EC (2.0 ml/lit.) + Neem seed kernel extract (50 g/lit.) along with spreader sticker.
10th	Fifteen days after 9th spray (at 100% fruit setting)	Bordeaux mixture (0.5%)
11th	Fifteen days after 10th spray	Captan 50 WP (2.5 g/lit.) + Bronopol (0.5 g/lit.) + Methomyl 40% SP (1.0 g/lit.) along with spreader sticker.

Spray schedule	Time of spray	Plant protection chemicals sprayed
12th	Fifteen days after 11th spray	Streptocycline (0.5 g/lit.) + Thiophanate Methyl 70 WP (1.0 g/lit.) + Acetamiprid 20 SP (0.3 g/lit.) along with spreader sticker.
13th	Fifteen days after 12th spray	Bordeaux mixture (0.5%)
14th	Fifteen days after 13th spray	Streptocycline (0.5 g/lit.) + copper hydroxide 77 WP (2.0 g/lit.) + Neem seed kernel extract (50 g/lit.) along with spreader sticker.
15th	Fifteen days after 14th spray	*Pseudomonas fluorescens* talc based formulation @ 2 g/lit. with continuous agitation.

Success Point/ Results

This IDIPM schedule was successfully validated by the ICAR-NRCP, Solapur in 2007-08 in a farmer's orchard of Mr. Subhash Dongare at Hiraj, Solapur. The validation plot (~1 ha) adopted was an orchard that had been abandoned by the grower because of severe bacterial blight infection (100% incidence and 80% severity). In the first year of implantation of OHM, reduction in bacterial blight incidence was 70% and severity 82.24% in comparison to neighboring Non-adopted orchard. The crop was harvested with a disease free marketable yield of 16 tons.

(a) Before implementation of IDIPM

(b) After implementation of IDIPM

Figure 1: Impact of implementation of IDIPM schedule on pomegranate fruit yield

The IDIPM schedule after validation was demonstrated in a network mode from 2008-2012 in 35 ha area of farmers orchards in Maharashtra, Karnataka, Andhra Pradesh and Telangana by ICAR-NRCP as nodal agency along with ICAR institutes and agriculture universities located in the states, with the funding from National Horticulture Mission. Out of 70 orchards adopted during 2008-09 and 2009-10, 57 orchards (81.43% orchards) were successfully managed for bacterial blight along with other diseases. The implementation of IDIPM schedule resulted in average blight reduction up to 86.04%, yield increase up to 79.5% with average B:C ratio of 4.19.

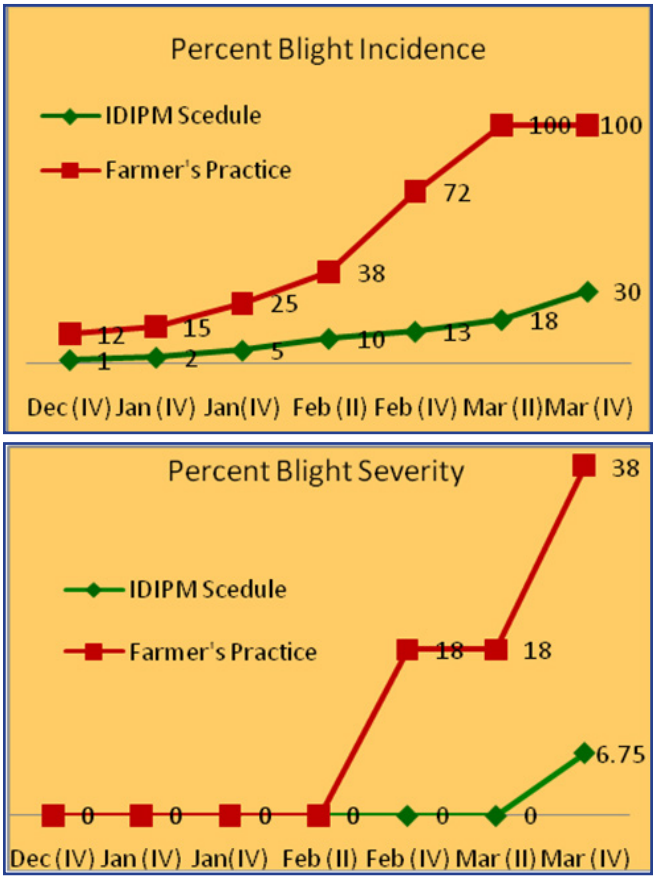

Figure 2: Effect of IDIPM schedule on bacterial blight disease in pomegranate

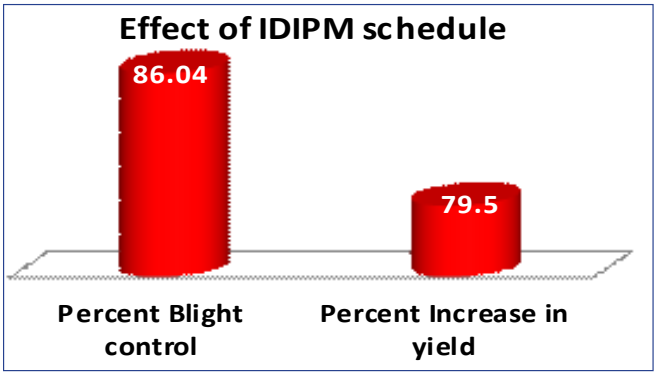

Figure 3: Effect of IDIPM schedule on bacterial blight disease control and improvement in fruit yield

Figure 4: Produce obtained by implementing IDIPM schedule at Kasegaon, Solapur

In an adopted orchard at Kasegaon, Tal- Pandharpur, dist. Solapur (MS), which lost up to 40% fruits in the previous year owing to bacterial blight disease, a 100 percent blight free fruit yield of 9.7 t/ha in the first year and 17.1 t/ha in the second year of demonstration was achieved with a cost benefit ratio of 2.69 and 5.66 in the two years respectively.

At Janoni, Tal.Mangalveda, Solapur (MS), the orchard adopted was 100 percent blight affected and the farmer could not take any produce in the previous 4 years. With the integrated schedule, the disease remained under check throughout the period and was only 2.25% at harvest with a disease free produce of 10.65 t and benefit:cost ratio of 3.10 (Figure 5).

Figure 5: Produce obtained by implementing IDIPM schedule at Janoni, Solapur

This was the first successful produce from the 5-6 year old pomegranate plantation. The non-adopted orchard lost fruits due to disease and produced only 0.675 t/ha fruits in the same season.

Figure 6: Produce obtained from demonstration of modified IDIPM schedule at Kurul, Solapur

The IDIPM schedule was modified based on promising research results of role of nutrients and salicylic acid (molecule imparting systemic acquired resistance in plant) in blight management at ICAR-NRCP and the modified IDIPM schedule was demonstrated in 5 farmers' orchards at Village Kurul and Shej-Babhulgaon, Taluka- Mohol, Solapur covering 12.5 acres area during the year 2014-15. Bacterial blight disease was reduced by 80.94 to 93.01% and yield increased by 30.49 to 63.21% in comparison to farmer's own practice plot. The average benefit was Rs. 7.47 lakh /ha (range 13.85 to 4.98 lakh Rs./ha) and average benefit to cost ratio was 6.8 (range 6.46 to 12.04).

Outcomes/ Impact of IDIPM Schedule on Bacterial Blight and Fruit Yield

The said technology exhibited cognizable success in reducing bacterial blight disease up to 72.05% with concomitant increase in yield up to 42.05% and average cost-benefit ratio of 1:4.19. The success of the technology resulted in adoption in different pomegranate growing states, which resulted in huge expansion of pomegranate area under cultivation, improved production, productivity and livelihood security of more than one lakh farm families in India.

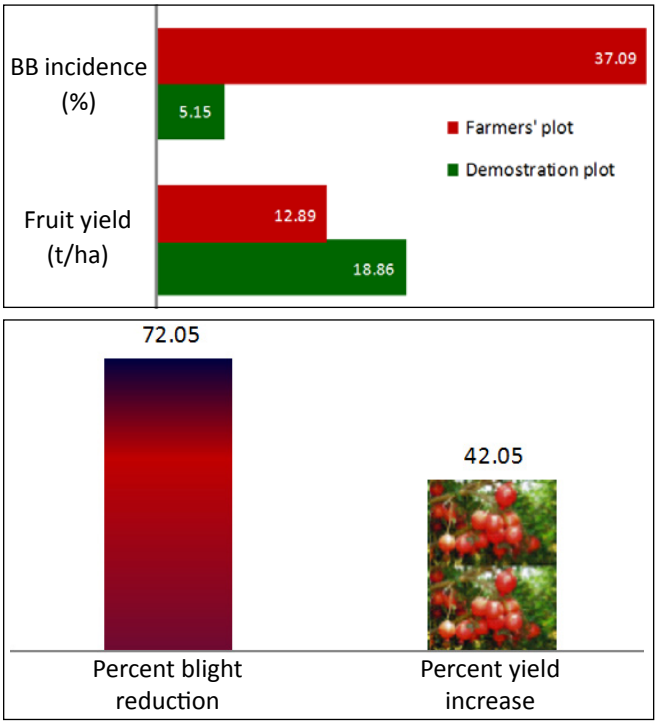

Figure 7: Impact of IDIPM schedule in management of bacterial blight disease in pomegranate

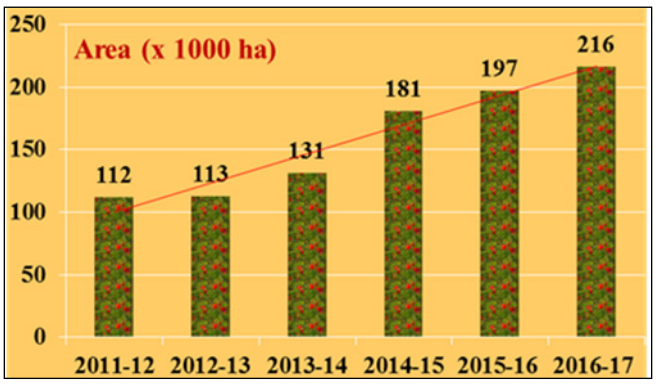

Figure 8 (a): Scenario of pomegranate area

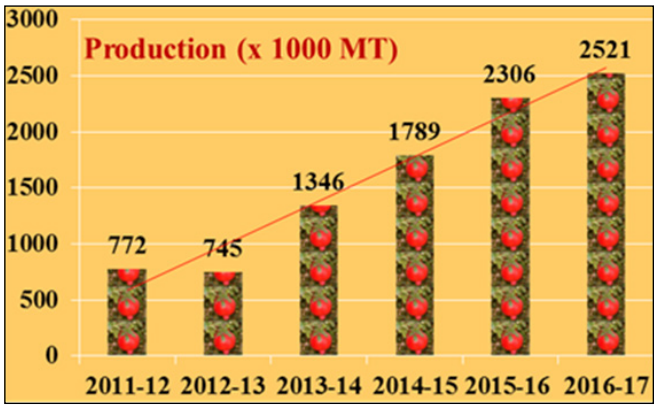

Figure 8 (b): Scenario of pomegranate production

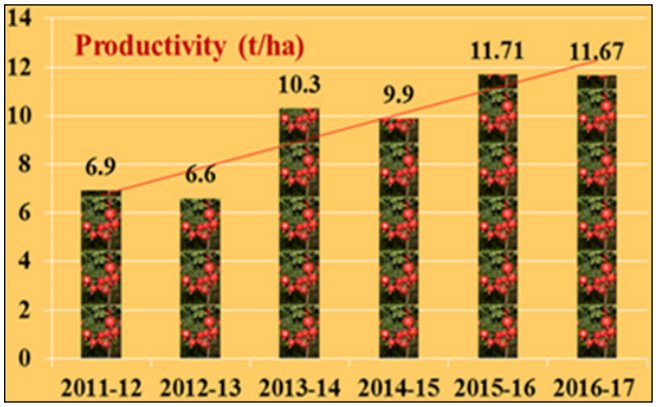

Figure 8 (c): Scenario of increasing pomegranate producivity over past six years

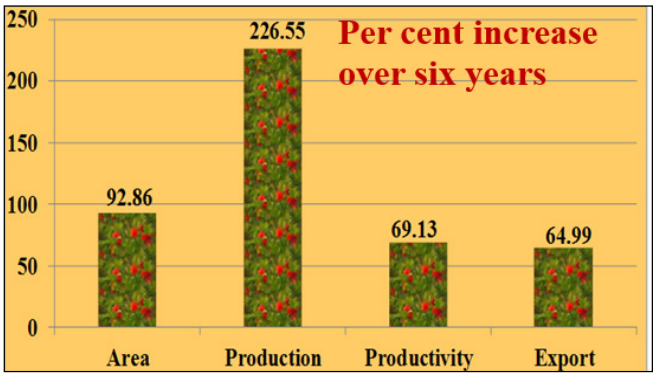

Figure 8 (d): Scenario of percentage increase in pomegranate producivity over past six years

The scenario can be evidenced from the national level figures on increasing area, production, productivity and export of pomegranate by 92.86%, 226.55%, 69.13% and 64.99% respectively in 2016-17 in comparison to 2011-12 figures.

Conclusion

On the basis of demonstration at farmers' field, it is inferred that bacterial blight disease of pomegranate could be managed to have profitable return using model pomegranate production practices (IDIPM schedule). If any spot appear in leaves of new plantation, the first and foremost step would be to get it confirm whether these spot are of bacterial blight disease or not from nearest research organization for under taking timely measures to prevent its further spread in the orchard.