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Management of prevalent diseases of bitter gourd (*Momordica charantia* L.)

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Abstract
Four diseases *viz*. downy mildew, powdery mildew, mosaic and leaf curlwere appeared during the course of investigation. The minimum days to first flowering (25.33 DAT), fifty per cent flowering (31.33 DAT) and first fruiting (29.67 DAT) and maximum days to fruit length (11.87 cm) and girth (5.43 cm), yield (108.96 q/ha) and benefit cost ratio (1:2.85) received from Seed treatment with seed pro @ 25g/kg + drenchig at first true leaf stage with seed pro @ 5% + spray of (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + Fosetyl-Al @ 0.1% + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1%.Minimum disease severity of downy mildew was recorded in treatment T5 (20.61%) i.e Seed treatment with (carbendazim 12%+ mancozeb 63% @ 3g/kg) + drenchig at first true leaf stage with (captan 70% + hexaconazole 5%WP @ 0.1%) + Spray of (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1%. The highest disease severity was recorded in treatment T7 (Control) *i.e.* 58.73%. The bitter gourd plants were free from powdery mildew in treatments such as T3 (Seed treatment with seed pro @ 25g/kg + drenchig at first true leaf stagewith seed pro @ 5% + spray of (captan 70% + hexaconazole 5% WP @ 0.1%) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% + (captan 70% + hexaconazole 5% WP @ 0.1%) + (imidacloprid 17.8 SL @7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1%), T4 (Seed treatment with seed pro @ 25g/kg + drenchig at first true leaf stage with seed pro @ 5% + spray of (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + Fosetyl-Al @ 0.1% + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1%) and T5 (Seed treatment with (carbendazim 12% + mancozeb 63% @ 3g/kg) + drenchig at first true leaf stage with (captan 70% + hexaconazole 5%WP @ 0.1%) + Spray of (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1%) were free from powdery mildew. The highest disease severity was recorded in treatment T7 (Control) *i.e*. 6.46%.Minimum disease incidence of leaf curl and mosaic treatment T4 (Seed treatment with seed pro @ 25g/kg + drenchig at first true leaf stage with seed pro @ 5% + spray of (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + Fosetyl-Al @ 0.1% + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1%) 18.67% and 12.33% respectively. The highest disease incidence of leaf curl and mosaic was recorded in T7 (control) 30.33% and 54.33% respectively.Yield of bitter gourd ranged from 108.96 to 82.99 q/ha. Maximum Yield (108.96 q/ha) was recorded in treatment T4 i.e. Seed treatment with seed pro @ 25g/kg + drenchig at first true leaf stage with seed pro @ 5% + spray of (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + Fosetyl-Al @ 0.1% + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1%. The lowest yield was recorded in T7 i.e. control (82.99 q/ha).The cost benefit ratio was ranged from 1:2.85 in T4 to 1:0.27 in T2. the best cost benefit ratio was obtained by T4 (1:2.85) i.e. Seed treatment with seed pro @ 25g/kg + drenchig at first true leaf stage with seed pro @ 5% + spray of (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + Fosetyl-Al @ 0.1% + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1%. The least cost benefit ratio (1:0.27) was obtained when treatment T2 [Seed treatment with carbendazim 12% + mancozeb 63% (@ 3g/kg) + drenchig at first true leaf stage with (captan 70% + hexaconazole 5% WP @ 0.1%) + 6 alternate spray of seed pro (1%) and neem oil (0.2%)] was applied.

Keywords: Diseases, Management, Bitter gourd Mancozeb and Treatment

Introduction
Bitter gourd, *Momordica charantia* L. is one of the most popular vegetable of Cucurbitaceae family in the tropical and subtropical countries (Palada and Chang, 2003 and Win *et al.*, 2014) [35, 48]. It is widely grown throughout South-east Asian countries including India, China and

Nepal (Abascal and Yarmell, 2005 and Raj *et al.*, 2010) [1, 24]. Bitter gourd is commonly attacked by number of diseases such as downy mildew, powdery mildew, gummosis, Phytophthora blight, anthracnose, Cercospora leaf spot, phoma blight, collar rot, Fusarium wilt, white rot, dampingoff of seedlings and fungal root rots, root knot nematode, bacterial wilt, bacterial leaf spot, mosaic, watermelon bud necrosis, leaf curl and leaf distortion virus. These diseases are of national importance and cause important economic losses in cucurbits (Mathew and Alice, 2002 [31], Pandey *et al.* 2002, Palada and Change, 2003 [35], Rai *et al.*, 2008 and Khan *et al.*, 2014). Among them downy mildew (Hansen, 2000 [18] and Rai and Yadav, 2005) [37], powdery mildew (Watson and Napier, 2009) [47], mosaic Ashwini *et al.*, 2016 [9], leaf curl (Raj *et al.*, 2010) [24], fusarium wilt (Rakhollya *et al.*, 2003) [40] and leaf spot are commonly effecting diseases that cause considerable loss to the crop (Balachandran, 2011 [10] and Abraham *et al.*, 2015) [2].

Downy mildew caused by *Pseudoperonospora cubensis* is one of the important foliar disease of bitter gourd. It was reported for the first time in 1868 and still it is are severe in bitter gourd, muskmelon, watermelon, cucumber, sponge gourd and ridge gourd (Hansen, 2000 [18] and Rai and Yadav, 2005 [37]). Symptoms first appear as pale green areas on the upper leaf surfaces. These change to yellow angular spots. A fine white to grayish downy growth soon appears on the lower leaf surface. Infected leaves generally die but may remain erect while the edges of the leaf blades curl inward. Usually, the leaves near the center of a hill or row are infected first. The infected area spreads outward, causing defoliation, stunted growth, and poor fruit development. The entire plant may eventually be killed (Kuepper, 2003 [26] and Rai and Yadav, 2005 [37]). During moist weather the corresponding lower leaf surface is covered with a downy, pale gray to purple mildew. The colour of the mildew ranges from white to near black. Infected leaves generally die but may remain erect, while edges of the leaf blade curl inward. Usually, the leaves near the centre of a hill or row are infected first. The infection area spreads outward, causing defoliation and poor fruit development which reduces yield. In rainy humid weather entire vein is killed (Babadoost 2001). Early infection of downy mildew can cause reduction in crop yield upto 60% where as late infection is less damaging (Colucci and Holmes, 2010 [13] and Wallace *et al.*, 2014 [46]). considered as one of the serious problem. In India, it is present all over the country except in high altitude temperate zone in the Himalaya. The lossesPowdery mildew caused by *Sphaerotheca fuliginea* and *Erysiphe cichoracearum* produce white powdery growth on the upper surfaces of leaves and on the stems of infected plants. Infected areas are often stunted and distorted and may drop prematurely from the plant. Fruits are usually not directly affected, but their size and growth may be stunted. Powdery mildew is caused by the fungi. *Erysiphe cichoracearum* and *Sphaerotheca fuliginea*. Infection can occur when temperatures are between 50 and 90 °F, during dry weather with high relative humidity (Anonymous, 2016).

Among the viral diseases bitter guard mosaic and leaf curl disease have become a most limiting factor for the cultivation of the crop in many places. The disease is responsible for a yield loss upto 100 per cent. The bitter gourd mosaic is caused by three different viruses viz. *Cucumber mosaic virus* (CMV), *Papaya ring spot virus* (PRSV) and *Bitter gourd distortion mosaic virus* (BDMV). *Cucumber mosaic virus* (CMV) infection of bitter gourd reported for the first time from Coimbatore, India (Nagarajan and Ramakrishnan, 1971). Symptoms appear as light and dark green mottling of the leaves, distortion of leaves and stunting of the plant might occur. Sometimes fruit might show sunken concentric circles or a raised marbled pattern. It is transmitted by five different species of aphid vectors and was tentatively named as Bitter gourd mosaic virus. The infection of PRSV a poty virus was described from cucurbitaceous plants with variable symptoms like vein clearing, mottling, malformed leaves and filimorphism (Anonymous, 1984). The association of BDMV with bitter guard was first reported in India from Kerala (Mathew *et al.*, 1991) [30]. The symptoms of BDMV infection in bitter gourd consists of upward curling, shortening of internodes, distortion of leaves, stunting of plants and deformation of fruits (Giri and Mishra, 1986 [16], Mathew and Alice, 2002 [31], Khan *et al.*, 2002, Tripathi and Varma, 2002 [44], Watson, 2009 [47] and Ashwini *et al.*, 2016) [9].

Leaf curl of bitter guard is a complex viral disease which is caused by three different viruses viz. Bitter guard leaf curl betasatellite virus (NCBI), Tomato leaf curl palampur virus (Ali, *et al.*, 2010) [3] Pepper leaf curl virus (Raj *et al.*, 2010) [24]. The symptoms of leaf curl are described as crumpling, vein thickening, severe yellow mosaic, slight curling of leaf tissues and stunting of plants. Infected plants produce less fruit, which were smaller in size as compared with those produced by healthy plants (Ali, *et al.*, 2010 [3] and Raj *et al.*, 2010) [24].

Among the all measures to raise the productivity level, plant protection is in central position. Plant protection is a basic exercise in any crop for control ofinsect-pests, diseases, weeds etc. to avoid economic losses. Reports indicate these losses ranging from 20-30 per cent by each of the insect-pests, diseases and weeds, but on a holistic basis about 30 per cent average cumulative loss by them appears a fair estimate. This implies that suitable control measures must be followed to keep these losses to the minimum (Muthuraman and Kumar, 2013 and Jana, 2014) [20]. In melon spraying of dithane M-45 (0.3%) at 15 days interval has been recommended to control downy mildew under Ludhiana conditions. In cucumber five sprays of dithane M-45, dithane Z-78 or aliette (all 0.3%), Mancozeb or Chlorothalonil @ 2 g/l twice at 10 intervals have been recommended to control downy mildew disease under Bangalore conditions. (Rai *et al.*, 2008 and Anonymous, 2013). Seed treatment with ridomil MZ 25% (metalaxyl 8% + mencozeb 64%) @ 0.25% + three times removal of lower leaves in the morning and spray of mencozeb 75% @ 0.25% in the afternoon on bower system significantly reduce the severity of downy mildew (Beura *et al.*, 2014). Downy mildew can be effectively controlled with sprays of Dithane M-45 (0.2%), Daconil and Difolatan (0.2%). One spraying gives protection for nine days. Copper oxychloride spray has also given good control. The sprays of Dithane M-45 if given early and repeated 2-3 times can control the disease effectively (Narkhede *et al.*, 2014) [34]. Management of downy mildew is achieved by the use of resistant variety (Karlhatti), tolerant variety like BTH-7, BTH-165, Phule green etc, with good cultural practices such as by using downy mildew free transplants, avoiding sprinkler irrigation and dense plant population and fungicide spray programmes.Fortnight spray of Carbendazim (0.1%), Culixin (0.05%), Karathane (0.5%) and Sulfex (0.2%), Dinocap 1ml/l or Carbendazim 0.5 g/l have been found effective against powdery mildew. Seed treatment and seed drenching with systemic fungicides also give protection to young seedlings. Wilt can be checked to some extent by drenching the soil with Captan or Hexocap or Thiride 0.2-0.3% solution. Use of disease free seed and cultivation of resistant varieties is the best way to control the disease incidence. It is brought down by seed treatment with Carbendazin or Benomyl. Hot water treatment @ 55 °C for 15 minutes also helps in eliminating seed-borne infection (Narkhede *et al.*, 2014) [34].

Cultural practices, i.e. use of tolerant varieties, sowing date, sowing depth, barrier crops, white plastic mulch, perforated plastic mulch, roughing of infected plants, destruction of collateral host plant and application of suitable insecticide may considerably reduce the yield loss caused by viral diseases (Mathew and Alice, 2002 [31], Tripathi and Varma, 2002 [44], Kaur and Kang, 2005 [21] and Watson, 2009) [47]. Chemical control of insect vectors by spraying Malathion at 5-7 days interval may partially check the spread (Narkhede *et al.*, 2014) [34]. For aphids vectors spraying of Imidachloprid @ 0.5 ml/lit along with sufficient quantity of stickers like Teepol, triton X100, apsa etc., for better adhesion and coverage. Spraying of Oxydemeton –Methyl 25% EC @ 1 ml/litre or Thiamethoxam 25% WG @ 4.0 ml/10 litre found effective against viral disease by reducing whitefly population.Most farmers depend on many commercial systemic and non-systemic fungicides and insecticides for managing fungal and viral diseases respectively. However, the indiscriminate use of pesticides in crop grown under intensive cultivation receive very high dose of fungicides and insecticides which lead to potential threats such as development of resistance to many diseases, pests, outbreak of secondary pests and accumulation of pesticide residues in the final produce (Kumar *et al.*, 2008). Moreover some chemical fungicides and insecticides have been observed effective in controlling the disease but these chemicals are very expensive and not environmentally safe (Relevante and Cumagun, 2013) [41]. Therefore, alternative solutions such as cultural and physical methods, use of bio control agents, botanical pesticides and resistant variety for sustainable control of this important disease must be explored. Though, there is no single disease management strategy is effective against diseases. Recently, there is a growing interest in development of integrated disease management strategies (Tripathi and Varma, 2002 [44] and Jana, 2014) [20]. Fungicides, however, have been widely recognised to have adverse environmental effects resulting in the withdrawal of such chemicals from the market. Some chemical fungicides such as carbendazim and benomyl have been observed effective in controlling the disease but these chemicals are very expensive and not environmentally safe. Therefore, alternative solutions for sustainable control of this important disease must be explored. Recently, there is a growing interest in using natural resources or natural methods of disease control toreduce pesticide use, an example of which is biofumigation and green manuring (Relevante and Cumagun, 2013) [41].

For the management of the disease. Several insecticides have been used to control the vector reported by various workers (Rataul and Butter, 1976; Mishra, 1984). The potential environmental pollution, health hazard and adverse effect on non-target insects in the use of insecticidal chemicals for the control of leaf curl disease (LCD) necessitated the development of alternative eco-friendly management strategies. Alternatively, non-chemical control methods such as use of mineral oil (Sharma and Varma, 1982), mulching (Suwwan *et al.,* 1988), protecting the plants in nurseries by physical barriers have been promising (Nakhla and Maxwell, 1998). In the present investigation some ecofriendly methods were tried for the management and epidemiological studies of LCD. Least incidence of the LCD was found in polythene mulch (PM) treatment and in perforated polythene cover (PC) treatment as compared to the other treatments. (Tripathi and Varma, 2002) [44].

Indiscriminate use of chemicals in agriculture during post green revolution period and their adverse effect on soil health and environment has created an alarming situation. A situation has resulted which urgently demands an environmentally safe, sustainable and simultaneously, economically viable production system. This indeed is essential for optimizing production and at the same time to minimize threat to environment (Jana, 2014) [20]. Looking to the magnitude of the diseases, like downy mildew and mosaic the lack of proper management of them the following objectives were framed for the present study.

Materials and methods

Seven different treatment combinations were evaluated against prevalent diseases of bitter gourd to find out best management combinations under organic condition at Horticultural Research Farm, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh.

Treatment details

T_0 -Growing of maize as border crop 15 days before sowing + silver mulching

T_1 -Seed treatment with bio-fungicide (seed pro @ 25g/kg seed) for organic farming + drenchig at first true leaf stage with seed pro @ 5% + 6 alternate spray of seed pro (1%) and neem oil (0.2%)

T_2 -Seed treatment with carbendazim 12% + mancozeb 63% (@ 3g/kg) + drenchig at first true leaf stage with (captan 70% + hexaconazole 5% WP @ 0.1%) + 6 alternate spray of seed pro (1%) and neem oil (0.2%)

T_3 -Seed treatment with seed pro @ 25g/kg + drenchig at first true leaf stage with seed pro @ 5% + spray of (captan 70% + hexaconazole 5% WP @ 0.1%) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% + (captan 70% + hexaconazole 5% WP @ 0.1%) + (imidacloprid 17.8 SL @7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1%

T_4 -Seed treatment with seed pro @ 25g/kg + drenchig at first true leaf stage with seed pro @ 5% + spray of (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + Fosetyl-Al @ 0.1% + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1%

T_5 -Seed treatment with (carbendazim 12%+ mancozeb 63% @ 3g/kg) + drenchig at first true leaf stage with (captan 70% + hexaconazole 5%WP @ 0.1%) + Spray of (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1%

T_6 -Seed treatment with (carbendazim 12%+ mancozeb 63% @ 3g/kg) + drenchig at first true leaf stage with (captan 70% + hexaconazole 5%WP @ 0.1%) + spray of (imidacloprid 17.8 SL @7.5 ml/15L+ neem oil 0.2%) + (captan 70% + hexaconazole 5%WP @ 0.1%) + Fosetyl-Al @ 0.1% + (captan 70% + hexaconazole 5%WP @ 0.1%) + (imidacloprid 17.8 SL @7.5 ml/15L + neem oil 0.2%)+ Fosetyl- Al @ 0.1%

T_7 -Control

* All the sprayswere applied at 10 days interval.

Experimental details

Experimental design	: RBD
Number of treatments	: 7
Number of replication	: 3
Distance between replication to replication	: 1 m
Plot size	: 4×5 m
Distance between two plots	: 1 m
Gross area	: 140 m^2
Number of plants per plot	: 4×5=20
Spacing	: 1×1 m

Plants of bitter gourd were raised in polyethene bags having one seed in each bag. Seeds were treated with bio control seed pro 25g/kg and Carbendazim 12% + Mencozeb 63% 3g/kgbefore sowing and control *i.e*. untreated one. Seed sowing of bitter gourd was done on 25th Nov 2015 and transplanting was done in the experimental plots on 17th Dec 2015.

Date of sowing, planting, harvesting and treatment applications

Cultural and technical work	Date
Date of nursery sowing	25-11-2015
Date of transplanting	17-12-2015
Date of first spraying of fungicide	27-12-2015
Date of second spraying of fungicide	07-01-2016
Date of third spraying of fungicide	17-01-2016
Date of forth spraying of fungicide	27-01-2016
Date of fifth spraying of fungicide	07-02-2016
Date of sixth spraying of fungicide	17-02-2016

Observation Schedule

In order to get representative samples, six plants (net and border) from management and five from varietal screening were selected in each plot and marked with tags for studying the diseases at various growth factors and the assessment of the other parameters and yield.

Disease severity and incidence

Percent disease severity and incidence for each plot were calculated by implying following formulae then the data were analyzed statistically.

$$\text{Per cent disease severity} = \frac{\text{Total leaf tissue damaged}}{\text{Total healthy tissue of leaf}} \times 100$$

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

Yield contributing parameters

Days to first flowering

First flowering days were recorded from the plants of each plot at an interval of one day and mean was calculated.

Days to 50% flowering

Fifty per cent flowering days were recorded from the plants of each plot at an interval of one day and mean was calculated.

Days to first fruiting

First fruiting days were recorded from the plants of each plot at an interval of one day and mean was calculated.

Fruit length

Five fruits from each plot were randomly selected. The length of selected fruits from each treatment was measured with the scale and average was calculated.

Fruit girth

Fruit girth was measured with the help of Vernier scale of randomly selected five fruits per plot and an average was found out.

Yield

Total weight (Net and Border) of bitter gourd harvested per plot from all the pickings was calculated and finally the yield quintal per hectare was worked out.

Economics and statistical analysis

Economics analyses of different treatments were worked out as per the rates of input applied for disease management and wages prevailing during the course of study.

Present experimental data was analyzed statistically by techniques of analysis of variance applicable to Randomized Block Design. The significance of treatments was tested by F-test value. Critical value at 5% level of significance was worked out for comparison and statistical interpretation of significant treatment means. The standard error of difference was given in each case for significant treatment effect, critical difference of different treatment combinations per interaction at 5% level of probability was calculated, wherever F-test was significant.

Results and discussion

To work out the suitable combination of methods for management of the disease for organic farming situation

The experimental data presented in Table 1indicated that disease severity of downy mildew in bitter gourd plant ranged from 20.61% to 26.76%. Minimum disease severity was recorded in treatment T5 (Seed treatment with (carbendazim 12%+ mancozeb 63% @ 3g/kg) + drenchig at first true leaf stage with (captan 70% + hexaconazole 5%WP @ 0.1%) + Spray of (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + FosetylAl @ 0.1%) 20.61%. This was followed by treatment T4 (Seed treatment with seed pro @ 25g/kg + drenchig at first true leaf stage with seed pro @ 5% + spray of (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + Fosetyl-Al @ 0.1% + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1%) 20.75% which is statistically at par with T5. The highest disease severity was recorded in treatment T7 (Control) i.e. 58.73% followed by T1 (Seed treatment with bio-fungicide (seed pro @ 25g/kg seed) for organic farming + drenchig at first true leaf stage with seed pro @ 5% + 6 alternate spray of seed pro (1%) and neem oil (0.2%) 25.41 per cent.

It was revealed from the Table 1 disease severity of powdery mildew in bitter gourd plant ranged from 0.0% to 6.46%. Treatments such as T3 (Seed treatment with seed pro @ 25g/kg + drenchig at first true leaf stage with seed pro @ 5% + spray of (captan 70% + hexaconazole 5% WP @ 0.1%) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% + (captan 70% + hexaconazole 5% WP @ 0.1%) + (imidacloprid 17.8 SL @7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1%), T4 (Seed treatment with seed pro @ 25g/kg + drenchig at first true leaf stage with seed pro

@ 5% + spray of (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + Fosetyl-Al @ 0.1% + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1%) and T5 (Seed treatment with (carbendazim 12% + mancozeb 63% @ 3g/kg) + drenchig at first true leaf stage with (captan 70% + hexaconazole 5%WP @ 0.1%) + Spray of (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1%) were free from powdery mildew. The highest disease severity was recorded in treatment T7 (Control) i.e. 6.46% followed by T6 (Seed treatment with (carbendazim 12%+ mancozeb 63% @ 3g/kg) + drenchig at first true leaf stage with (captan 70% + hexaconazole 5%WP @ 0.1%) + spray of (imidacloprid 17.8 SL @7.5 ml/15L+ neem oil 0.2%) + (captan 70% + hexaconazole 5%WP @ 0.1%) + Fosetyl-Al @ 0.1% + (captan 70% + hexaconazole 5%WP @ 0.1%) + (imidacloprid 17.8 SL @7.5 ml/15L + neem oil 0.2%)+ Fosetyl- Al @ 0.1%) 6.37 per cent.

The results are in agreement with the findings of Beura *et al.* (2014) they conducted an experiment to test the different integrated approaches for management of bitter gourd along with bower system and non bower system. Four years pooled data revealed that all the treatments of bower system of planting lowered the disease severity as compared to non bower system of planting. Among the fourteen treatments tested, integrated disease management components like seed treatment with ridomil mz (metalaxyl 8% + mancozeb 64%) @ 0.25% + three times removal of lower infected leaves in the morning and spray of mancozeb 75% @ 0.25% in the afternoon on bower system recorded significantly lowest disease severity of downy mildew (4.7%) with maximum fruit yield of 90.2 q ha-1. The same treatment also registered 92.24% disease control over control plots followed by seed treatment with ridomil mz (metalaxyl 8% + mancozeb 64%) @ 0.25% along with one foliar spray of alliete (fosetyl-al) @ 0.25% on bower system of planting registered 79.87% disease control. However, the check plot recorded the maximum disease severity of 60.60% and 46.60% with minimum green fruit yield of 33.50% q ha-1 and 41.1 q ha-1 in non bower and bower system of planting respectively. Zhang *et al.* (2015) reported that an integrated approach using a combination of several practices is most effective in managing downy mildew and powdery mildew diseases of bitter gourd. Shankar *et al.* (2014) suggested that application of some fungicides as protective treatment reduce the incidence and severity of downy mildew in cucurbits. Mancozeb (Dithane M-45) 2g/litre used as a protective application at 5-7 days interval or Azoxystrobin (amistar) 0.5ml/litre no more than two application per season, can be tank mixed with protectant fungicide, Dimethomorph (Acrobat) 1g/litre at 5-10 days interval not more than five application per season, Cymoxanil + Mancozeb (Curzate) 2g/litre at 5-7 day interval no more than four application, Fosetylaluminium (Aliette) 3g/litre preventive treatment prior to disease onset foliar application or Chlorothalonil (kavach) 2g/litre can be used as a protective application at 5-7 days interval. They also suggested that application of some fungicides such as Azoxystrobin (Amistar) 0.5ml/litre no more than two application per season, Chlorothalonil (kavach) 2g/litre can be used as a protective application at 5-7 days interval, Myclobutanil (Systhane) 1g/litre at 7-10 day interval; 30 day plant back restriction, Pyraclostrobin (cabrio) 1g/litre at 7-14 day interval; no more than two sequential application or Tebuconozole (Folicur) 1ml/litre at 10-14 day interval for suppression only protective treatment effectively reduce the incidence and severity of powdery mildew in cucurbits.

The experimental data presented in Table 1 indicated that disease incidence of leaf curl and mosaic in bitter gourd plant ranged from 18.67% to 30.33% and 12.33% to 54.33% respectively. Minimum disease incidence of leaf curl and mosaic treatment T4 (Seed treatment with seed pro @ 25g/kg + drenchig at first true leaf stage with seed pro @ 5% + spray of (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + Fosetyl-Al @ 0.1% + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1%) 18.67% and 12.33% respectively. This was followed by treatment T5 (Seed treatment with (carbendazim 12%+ mancozeb 63% @ 3g/kg) + drenchig at first true leaf stage with (captan 70% + hexaconazole 5%WP @ 0.1%) + Spray of (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1%) 20.67% and 22.00% and T3 (Seed treatment with seed pro @ 25g/kg + drenchig at first true leaf stage with seed pro @ 5% + spray of (captan 70% + hexaconazole 5% WP @ 0.1%) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% + (captan 70% + hexaconazole 5% WP @ 0.1%) + (imidacloprid 17.8 SL @7.5 ml/15L + neem oil 0.2%) + FosetylAl @ 0.1%) 21.67% and 25.00% respectively. The highest disease incidence of leaf curl and mosaic was recorded in T7 (control) 30.33% and 54.33% respectively.

Kurowski *et al.* (2015) suggested that management of mosaic and leaf curl of cucurbits has been only marginally successful through vector control (*e.g.,* insecticides, stylet oils). Avoid planting near older cucurbits and perennial ornamental crops, which may serve as reservoirs for the virus. Control weeds, use reflective mulches, deep plough crop residues and dispose of infected greenhouse material to manage these viruses. Implement a comprehensive sanitation program for workers and equipment to minimize disease spread. Commercial varieties with resistance offer the best means to control mosaic and leaf curl. Resistance in cucumber has been shown to be very effective on a global scale. Progress in finding resistance in other cucurbit species has not been as successful. Khan *et al.* (2006) reported that regular spraying of insecticide at every 21 days interval was found to be effective for management of mosaic and leaf curl disease of chilli. An improvement in growth and yield performance of treated plants was noticed as compared to the non-treated plants. Kaur and Kang (2005) [21] conducted field experiments in Punjab, India, to determine the effect of cultural practices, i.e. sowing date, sowing depth and the use of barrier crops, i.e. sunflower, gobhi sarson (Brassica campestris var. sarson) and raya (Brassica juncea) alone and in combination with sprays of malathion and Thiodan (endosulfan) either on the barrier crop or on the main crop for the management of cucurbit mosaic caused by Watermelon mosaic virus and Potato virus Y on summer squash PB Chappan, Kadoo-1 and musk melon Pb Sunehri. The treatments reduced mosaic incidence in both crops. Crops sown in the second fortnight of March registered the least disease incidence (52.1 and 54.0%) and severity (54.3 and 57.9%) in summer squash and muskmelon, respectively, without reductions in yield. Further delay in sowing up to the end of April reduced the disease incidence but yield was also reduced. Increase in sowing depth up to 9.00 cm reduced the disease incidence by 23.34% in summer squash and 24.61% in muskmelon but adversely affected the germination and the crop stand. The disease was also lowest in these crops when sunflower was grown as a barrier crop. However, sowing of sunflower as barrier crop and spray of Thiodan on the main crop further reduced the disease incidence (37.24%) and severity (40.34%). The sowing of gobhi sarson and raya alone or the sprays of insecticides on these crops had no positive effect in disease reduction. However, the sprays of insecticides on the main crop reduced disease incidence and severity even when gobhi Sarson and Raya were sown as barrier crops.

Table 1: Effect of different combinations of methods for management of the disease for organic farming situation

Treatment	Per cent disease severity (90 DAT)		Per cent disease incidence (90 DAT)	
	Downy mildew	Powdery mildew	Leaf curl	Mosaic
T_1	25.41 (5.14)*	6.46 (2.73)*	23.67 (29.09)**	41.33 (39.99)**
T_2	23.23 (4.92)	4.52 (2.35)	23.67 (29.09)	27.00 (31.28)
T_3	23.05 (4.90)	0.00 (1.00)	21.67 (27.72)	25.00 (29.98)
T_4	20.75 (4.65)	0.00 (1.00)	18.67 (25.58)	12.33 (20.53)
T_5	20.61 (4.64)	0.00 (1.00)	20.67 (27.02)	22.00 (27.94)
T_6	23.60 (4.96)	6.37 (2.71)	23.33 (28.87)	26.33 (30.82)
T_7	26.76 (5.27)	5.34 (2.51)	30.33 (33.41)	54.33 (47.47)
SEm(±)	**0.126**	**0.076**	**0.600**	**0.807**
C.D. (5%)	**0.393**	**0.237**	**1.852**	**2.515**
C.V.	**4.434**	**6.934**	**3.590**	**4.293**

* Data in parentheses are square root transformed
** Data in parentheses are arcsine (angular) transformed

To study the response of various treatments on yield and its parameter of bitter gourd

Days to first flowering

The data presented in Table 2 indicated that the minimum days to first flowering was recorded under treatment T_4 (25.33 DAT) *i.e.* Seed treatment with seed pro @ 25g/kg + drenchig at first true leaf stage with seed pro @ 5% + spray of (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + Fosetyl-Al @ 0.1% + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1%. This was followed by T_3 i.e. Seed treatment with seed pro @ 25g/kg + drenchig at first true leaf stage with seed pro @ 5% + spray of (captan 70% + hexaconazole 5% WP @ 0.1%) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% + (captan 70% + hexaconazole 5% WP @ 0.1%) + (imidacloprid 17.8 SL @7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% and T_5 i.e. Seed treatment with (carbendazim 12%+ mancozeb 63% @ 3g/kg) + drenchig at first true leaf stage with (captan 70% + hexaconazole 5%WP @ 0.1%) + Spray of (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% (25.67 DAT) which was statistically at par with T_4. Maximum number of days to first flowering was recorded in control (29 DAT).

Days to 50% flowering

It was revealed form the data presented in Table 2 that the minimum days to fifty per cent flowering was recorded under treatment T_4 (31.33 DAT) *i.e.* Seed treatment with seed pro @ 25g/kg + drenchig at first true leaf stage with seed pro @ 5% + spray of (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + Fosetyl-Al @ 0.1% + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1%. This was followed by T_3 i.e. Seed treatment with seed pro @ 25g/kg + drenchig at first true leaf stage with seed pro @ 5% + spray of (captan 70% + hexaconazole 5% WP @ 0.1%) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% + (captan 70% + hexaconazole 5% WP @ 0.1%) + (imidacloprid 17.8 SL @7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1%, T_5*i.e.* Seed treatment with (carbendazim 12%+ mancozeb 63% @ 3g/kg) + drenchig at first true leaf stage with (captan 70% + hexaconazole 5%WP @ 0.1%) + Spray of (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% and T_6 Seed treatment with (carbendazim 12%+ mancozeb 63% @ 3g/kg) + drenchig at first true leaf stage with (captan 70% + hexaconazole 5%WP @ 0.1%) + spray of (imidacloprid 17.8 SL @7.5 ml/15L+ neem oil 0.2%) + (captan 70% + hexaconazole 5%WP @ 0.1%) + Fosetyl-Al @ 0.1% + (captan 70% + hexaconazole 5%WP @ 0.1%) + (imidacloprid 17.8 SL @7.5 ml/15L + neem oil 0.2%)+ Fosetyl- Al @ 0.1% (32.33 DAT). which was statistically at par with T_4. Maximum number of days to fifty per cent flowering was recorded in control (36 DAT).

Days to first fruiting

It was revealed form the data presented in Table 2 that the minimum days to first fruiting was recorded under treatment T_4 (29.67 DAT) *i.e.* Seed treatment with seed pro @ 25g/kg + drenchig at first true leaf stage with seed pro @ 5% + spray of (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + Fosetyl-Al @ 0.1% + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1%. This was followed by T_3 i.e. Seed treatment with seed pro @ 25g/kg + drenchig at first true leaf stage with seed pro @ 5% + spray of (captan 70% + hexaconazole 5% WP @ 0.1%) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% + (captan 70% + hexaconazole 5% WP @ 0.1%) + (imidacloprid 17.8 SL @7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% (30.00 DAT) and T_5*i.e.* Seed treatment with (carbendazim 12%+ mancozeb 63% @ 3g/kg) + drenchig at first true leaf stage with (captan 70% + hexaconazole 5%WP @ 0.1%) + Spray of (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% (30.33 DAT). Which were statistically at par with T_4. Maximum number of days to first fruiting was recorded in control (33.33 DAT).

Fruit length

Fruit length of bitter gourd ranged from 11.87 cm to 10.05 cm. The maximum length of fruit observed in treatment T_4 (Seed treatment with seed pro @ 25g/kg + drenchig at first true leaf stage with seed pro @ 5% + spray of (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + Fosetyl-Al @ 0.1% + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1%) was 11.87 cm, which was significantly higher than untreated control (10.05 cm). This was followed by T_3*i.e*. Seed treatment with seed pro @ 25g/kg + drenchig at first true leaf stage with seed pro @ 5% + spray of (captan 70% + hexaconazole 5% WP @ 0.1%) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% + (captan 70% + hexaconazole 5% WP @ 0.1%) + (imidacloprid 17.8 SL @7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% (11.65 cm) and T_5 (11.65 cm) *i.e*. Seed treatment with (carbendazim 12%+ mancozeb 63% @ 3g/kg) + drenchig at first true leaf stage with (captan 70% + hexaconazole 5%WP @ 0.1%) + Spray of (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1%. The minimum fruit length was recorded in control, as is evident from the Table 2.

Fruit girth

Fruit girth of bitter gourd ranged from 5.43 to 3.20 cm. The maximum girth of the fruit was attained by treatment T_4 (Seed treatment with seed pro @ 25g/kg + drenchig at first true leaf stage with seed pro @ 5% + spray of (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + Fosetyl-Al @ 0.1% + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1%) 5.43 cm, (Table 4.11 and Figure 4.4) which was significantly higher than untreated control. This was followed by T_5*i.e*. Seed treatment with (carbendazim 12%+ mancozeb 63% @ 3g/kg) + drenchig at first true leaf stage with (captan 70% + hexaconazole 5%WP @ 0.1%) + Spray of (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% (4.38 cm) and T_3*i.e*. Seed treatment with seed pro @ 25g/kg + drenchig at first true leaf stage with seed pro @ 5% + spray of (captan 70% + hexaconazole 5% WP @ 0.1%) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% + (captan 70% + hexaconazole 5% WP @ 0.1%) + (imidacloprid 17.8 SL @7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% (4.05 cm) which were statistically at par with each other. The minimum fruit girth was recorded in the fruits picked from control (3.20 cm).

Yield (q/ha)

The yield of bitter gourd under different treatments was presented in Table 3 and Figure 4.5. Total ten picking was done. Yield of bitter gourd ranged from 108.96 to 82.99 q/ha. Maximum Yield was recorded in treatment T_4 (Seed treatment with seed pro @ 25g/kg + drenchig at first true leaf stage with seed pro @ 5% + spray of (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + Fosetyl-Al @ 0.1% + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1%) 108.96 q/ha, which was significantly higher than untreated control. This was at followed by T_5*i.e*. Seed treatment with (carbendazim 12%+ mancozeb 63% @ 3g/kg) + drenchig at first true leaf stage with (captan 70% + hexaconazole 5%WP @ 0.1%) + Spray of (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% (100.63 q/ha) and T_3*i.e*. Seed treatment with seed pro @ 25g/kg + drenchig at first true leaf stage with seed pro @ 5% + spray of (captan 70% + hexaconazole 5% WP @ 0.1%) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% + (captan 70% + hexaconazole 5% WP @ 0.1%) + (imidacloprid 17.8 SL @7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% (98.46 q/ha) which were statistically at par with T_4. The lowest yield was recorded in T_7*i.e*. control (82.99 q/ha).

Manjusha (2007) reported that the minimum days to first flowering were recorded under treatment T_1*i.e*. spray of Curzate, the maximum length of fruit observed in treatment T_7 (Seed treatment Ridomil MZ @ 2.5g/Kg seed + spray of curzate @ 2.5gm/litre of water), the maximum girth of the fruit is attained by treatment T_1 (Seed treatment Ridomil MZ @ 2.5g/Kg seed + need based spray of curzate @ 2.5gm/litre of water and Maximum Yield was recorded in treatment T_1 (Seed treatment Ridomil MZ @ 2.5g/Kg seed + need based spray of curzate @ 2.5gm/litre of water) 57.44 q/ha.

Table 2: Effect of different treatment combinations on flowering and fruiting of bitter gourd

Treatment	flowering parameters (DAT)			Fruit parameters	
	First flowering	50% flowering	First fruiting	Fruit length (cm)	Girth (cm)
T_1	26.33	32.67	31.33	10.80	3.97
T_2	26.00	33.33	30.67	10.68	3.57
T_3	25.67	32.33	30.00	11.65	4.05
T_4	25.33	31.33	29.67	11.87	5.43
T_5	25.67	32.33	30.33	11.65	4.38
T_6	26.00	32.33	30.67	11.15	3.91
T_7	29.00	36.00	33.33	10.05	3.20
SEm(±)	**0.845**	**0.790**	**0.903**	**0.334**	**0.316**
C.D. (5%)	**2.604**	**2.435**	**2.781**	**1.029**	**0.973**
C.V.	**6.210**	**4.374**	**5.622**	**5.204**	**13.428**

Table 3: Effect of different treatment combinations on yield of bitter gourd

Treatment	Yield (q/ha)		
	Marketable	Unmarketable	Total
T_1	92.58	15.22	107.79
T_2	84.54	16.59	101.13
T_3	98.46	12.46	110.92
T_4	108.96	13.58	122.53
T_5	100.63	15.02	115.64
T_6	93.18	14.85	108.03
T_7	82.99	13.32	96.31
SEm(±)	**4.788**	**2.865**	**5.793**
C.D. (5%)	**14.754**	**8.829**	**17.849**
C.V.	**8.778**	**34.387**	**9.213**

Economics of different management practices

The economics of different management practices was shown in Table 4. The average rate of produce throughout the season was Rs. 40/kg (Rs. 4000/q). The value of produce was ranged from Rs. 435832 in T_4 (Seed treatment with seed pro @ 25g/kg + drenchig at first true leaf stage with seed pro @ 5% + spray of (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + Fosetyl-Al @ 0.1% + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1%) to Rs. 331948 in untreated control. The maximum value of produce (Rs. 435832) earned from T_4. This was followed by T_5*i.e*. Seed treatment with (carbendazim 12%+ mancozeb 63% @ 3g/kg) + drenchig at first true leaf stage with (captan 70% + hexaconazole 5%WP @ 0.1%) + Spray of (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% (Rs. 402500) and T_3*i.e*. Seed treatment with seed pro @ 25g/kg + drenchig at first true leaf stage with seed pro @ 5% + spray of (captan 70% + hexaconazole 5% WP @ 0.1%) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% + (captan 70% + hexaconazole 5% WP @ 0.1%) + (imidacloprid 17.8 SL @7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% (Rs. 393836). While the least value of produce was earned form control (Rs. 331948).

The total cost for management practices was ranged from Rs. 36458.24 in T_4 to Rs. 18856.32 in T_6 (Seed treatment with (carbendazim 12%+ mancozeb 63% @ 3g/kg) + drenchig at first true leaf stage with (captan 70% + hexaconazole 5%WP @ 0.1%) + spray of (imidacloprid 17.8 SL @7.5 ml/15L+ neem oil 0.2%) + (captan 70% + hexaconazole 5%WP @ 0.1%) + Fosetyl-Al @ 0.1% + (captan 70% + hexaconazole 5%WP @ 0.1%) + (imidacloprid 17.8 SL @7.5 ml/15L + neem oil 0.2%)+ Fosetyl- Al @ 0.1%). Maximum cost was invested in T_4 (Rs. 36458.24) this was followed by T_1 (Rs. 29936.20) *i.e*. Seed treatment with bio-fungicide (seed pro @ 25g/kg seed) for organic farming + drenchig at first true leaf stage with seed pro @ 5% + 6 alternate spray of seed pro (1%) and neem oil (0.2%) and T_5 (Rs. 29736.32). The least cost was invested in T_6 (Rs. 18856.32).

The cost benefit ratio was ranged from 1:2.85 in T_4 to 1:0.27 in T_2. It was revealed from the data presented in Table 4.13 and Figure 4.6 that the best cost benefit ratio was obtained by T_4 (1:2.85) *i.e*. Seed treatment with seed pro @ 25g/kg + drenchig at first true leaf stage with seed pro @ 5% + spray of (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + Fosetyl-Al @ 0.1% + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1%. This was followed by T_3 (1:2.42) *i.e*. Seed treatment with seed pro @ 25g/kg + drenchig at first true leaf stage with seed pro @ 5% + spray of (captan 70% + hexaconazole 5% WP @ 0.1%) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% + (captan 70% + hexaconazole 5% WP @ 0.1%) + (imidacloprid 17.8 SL @7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% and T_5 (1:2.37) *i.e*. Seed treatment with (carbendazim 12%+ mancozeb 63% @ 3g/kg) + drenchig at first true leaf stage with (captan 70% + hexaconazole 5%WP @ 0.1%) + Spray of (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1%. The least cost benefit ratio (1:0.27) was obtained when treatment T_2 [Seed treatment with carbendazim 12% + mancozeb 63% (@ 3g/kg) + drenchig at first true leaf stage with (captan 70% + hexaconazole 5% WP @ 0.1%) + 6 alternate spray of seed pro (1%) and neem oil (0.2%)] was applied.

Manjusha (2007) and Holmes (2005) reported that maximum return was recorded under spray of Curzate and Macozeb.

Table 4: Economics of different management practices

1	2	3	4	5	6	7	8
Treat-ment	**Marketable yield (q/ha)**	**Rate of produce (Rs/q)**	**Value of produce (Rs)**	**Total cost (Rs)**	**Value of produce in treatment - Value of produce in control (Rs)**	**Per Re value (6/5)**	**B:C ratio**
T_1	92.575	4000	370300	29936.20	38352	1.28	1:1.28
T_2	84.541	4000	338164	23205.08	6216	0.27	1:0.27
T_3	98.459	4000	393836	25578.24	61888	2.42	1:2.42
T_4	108.958	4000	435832	36458.24	103884	2.85	1:2.85
T_5	100.625	4000	402500	29736.32	70552	2.37	1:2.37
T_6	93.175	4000	372700	18856.32	40752	2.16	1:2.16
T_7	82.987	4000	331948	-	-	-	-

Conclusion

Three management practices T4 [Seed treatment with seed pro @ 25g/kg + drenchig at first true leaf stage with seed pro @ 5% + spray of (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + Fosetyl-Al @ 0.1% + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1%], T3 [Seed treatment with seed pro @ 25g/kg + drenchig at first true leaf stage with seed pro @ 5% + spray of (captan 70% + hexaconazole 5% WP @ 0.1%) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% + (captan 70% + hexaconazole 5% WP @ 0.1%) + (imidacloprid 17.8 SL @7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1%] and T5 [Seed treatment with (carbendazim 12%+ mancozeb 63% @ 3g/kg) + drenchig at first true leaf stage with (captan 70% + hexaconazole 5%WP @ 0.1%) + Spray of (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1% + (tebuconazole 50% + trifloxistrobin 25% WG @ 1g/l) + (imidacloprid 17.8 SL @ 7.5 ml/15L + neem oil 0.2%) + Fosetyl-Al @ 0.1%] significantly reduced disease severity of downy and powdery mildew and disease incidence of leaf curl and mosaic.

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