Crop protection technologies generated through AICRP-Groundnut

ICAR-Directorate of Groundnut Research
(An ISO 9001 : 2015 Certified Institute)
Ivnagar Road, PO Box No. 5, Junagadh-362 001, Gujarat, India

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Ram Dutta
Nataraja MV
Thirumalaisamy PP
Harish G
Radhakrishnan T

ICAR-Directorate of Groundnut Research
(An ISO 9001 : 2015 Certified Institute)
Ivnagar Road, PO Box No. 5, Junagadh-362 001, Gujarat, India

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Director and Project Coordinator,
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Post Box 05, Ivnagar Road,
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http://www.dgr.org.in
director.dgr@icar.gov.in
0285-2672550
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नई दिल्ली 110001, भारत

Indian Council of Agricultural Research
Ministry of Agriculture and Farmers Welfare
Govt. of India, Krishi Bhavan
New Delhi 110001, India

डॉ. तिलक राज शर्मा
उप महानिदेशक (फसल विज्ञान)

Dr. T. R. Sharma, Ph.D
FNA, FNAAS, FNASc, JC Bose National Fellow
Deputy Director General (Crop Science)

MESSAGE

Groundnut is an important oilseed crop which plays a significant role in meeting ever increasing demand for edible oil. It is also gaining popularity as an ancillary and confectionery food in India. This crop has the potential to address food and nutritional security of the country. Groundnut is popularly known as "Poor man's Almond" due to rich nutrient and essential fatty acid profile. Groundnut is grown mainly rainfed, on poorly/marginally nourished soils and thus contributing to sustained livelihood of farmers in the drought-prone areas like, Anantapur of Andhra Pradesh and Chitradurga of Karnataka where, the mean rainfall is below 575 mm per annum. In the regions around Bikaner-Jodhpur (Rajasthan), and Thiruvallur (Tamil Nadu) higher pod yield *i.e.* above 4000 kg /ha is also being realized. Groundnut pods and haulms are equally important for farmers as haulms serve as fodder for livestock. Insect-pests and diseases which affect both pod and haulm yields can severely affect groundnut cultivation. Each groundnut growing region is diagnosed with different set of insect-pest and disease problems for different growing seasons like, *Kharif* and *Rabi*-Summer. Hence, pest management technologies must be developed considering specific requirements of each region/ cropping season.

In this context, it is essential to have a compilation of the improved technological advancements made at various network centres and research organizations located in different groundnut growing areas of the country. All India Co-ordinated Research Project on Groundnut (AICRP-G) fits the bill, in formulating and validating technologies across the regions. Best and low-cost technologies identified must be popularized among farmers to double farm income by reducing the crop losses.

I am pleased to learn that the AICRP-G Crop Protection team under the leadership of the Director, ICAR-Directorate of Groundnut Research has come up with a handy publication "***Crop Protection Technologies Generated through AICRP-G***" for insect-pest and disease management in groundnut. I place on record my sincere appreciation to all the contributors of the technologies and I am sure it will be useful to the end-users and policy makers alike to promote groundnut farming. I compliment AICRP-G Crop Protection team for their concerted efforts in bringing out this useful bulletin.

(T.R. Sharma)

E-mail: ddgcs.icar@nic.in Phone: 91-11-23382545 Fax: 91-11-23097003

Preface

Groundnut is an important oilseed-food-feed-fodder crop grown largely under rainfed conditions mainly for livelihood. The crop annually incurs losses amounting to ~ Rs. 238 crores due to biotic stresses from insect-pests and diseases. Management of insect-pests and diseases are seldom uniform across the groundnut growing regions of India, due to diversity in cultivation, edaphic and weather factors. ICAR-Directorate of Groundnut Research, Junagadh, Gujarat connects several research stations of State Agricultural Universities spread across India through All India Co-ordinated Research Project on Groundnut (AICRP-G). This project acts as a platform for groundnut scientists to interact, exchange ideas, identify and validate suitable technologies for insect-pest and disease management.

Insect-pests of national significance are tobacco caterpillar, gram pod borer, leaf miner, thrips, leafhoppers, white grubs and bruchids which occur throughout groundnut growing regions. Some insect-pests have regional significance like, aphids in Telangana, Maharashtra and Odisha; red-headed hairy caterpillar in Andhra Pradesh and Karnataka; and termites in Rajasthan, Uttar Pradesh, Punjab and Odisha. Likewise, diseases of groundnut with national significance are leaf spots, rust, *Alternaria* leaf blight, stem rot, collar rot, dry root rot, afla-root and menace of aflatoxin. Some diseases have regional significance which includes peanut stem necrosis (Andhra Pradesh), peanut bud necrosis (Andhra Pradesh and Karnataka) and peanut clump (Rajasthan).

In general, *Kharif* groundnut faces threats from insects like, tobacco caterpillar, leaf miner, thrips, white grubs and termites; and diseases like, stem rot, leaf spots, rust and PSND/PBND while, *Rabi*-summer groundnut cultivation is affected by insects like, leafhoppers, aphids and thrips; and *Alternaria* leaf blight disease. Looking into their severity, seasonality, spread and significance, several crop protection technologies were formulated in the form of trials and validated at respective AICRP-G centres to identify their rationale and best performance for states. In this bulletin, sincere effort has been made to aggregate such crop protection technologies recommended in the Annual Groundnut Meetings during the last decade (2010-2020). These technologies include management strategies and IPM modules for the effective management of insect-pests and diseases. Stakeholders like, farmers, extension workers, scientists and policy makers will be benefitted from this compilation.

We congratulate the team Crop Protection (AICRP-G) for their achievements and acknowledge their contribution in generating technologies included in this bulletin.

Authors

Introduction

Groundnut is an important oilseed and ancillary food crop of the world. Besides expulsion of oil, it is used for production of groundnut-butter and a host of other food products. India has the largest groundnut growing area in the world and is the second largest producer after China. Gujarat, Andhra Pradesh, Tamil Nadu, Rajasthan, Karnataka and Maharashtra are the major groundnut growing states of India and together account for about 90% of the national area under groundnut.

In India, groundnut is cultivated during *Kharif*, *Rabi* and summer seasons under various cropping systems, and it occupies the third place among oilseed crops and grown in an area of about 5.06 m ha with the production of 8.05 mt and productivity of 1583 kg/ha (Quinquennial Average, 2014-2018). The low productivity in India is largely of the crop is rainfed and exposed to various abiotic and biotic stresses. The estimated annual losses of approximately Rs. 238 crore in groundnut are due to insect-pests, diseases and weeds.

The insect-pests inflicting foliar damage to crop, are known as defoliator pests. Most important defoliator pests of groundnut in India are, tobacco caterpillar, groundnut leaf miner, gram pod borer and red-headed hairy caterpillar Sap-sucking pests namely, aphids, leafhoppers and thrips are major threat to groundnut cultivation. Aphids are principally a rainy season pest while, leafhoppers and thrips occur both in rainy and post-rainy seasons. Apart from causing direct damage to the crop, aphids and thrips act as vector for important viral diseases like, peanut stunt virus (*PSV*) and peanut bud necrosis virus (*PBNV*), respectively. Among sub-terranean pests, white grubs, termites, wireworms, and earwigs damage the pods. Bruchid, is of greater importance in storage.

More than 55 pathogens including viruses have been reported to affect groundnut. Among fungal diseases, only a few are economically important in India such as collar rot, stem rot, dry root rot, leaf spots (early and late), rust and *Alternaria* leaf blight which are widely distributed and can cause losses. Leaf spot and rust cause crop losses to an extent of 70-80 per cent when both occur together. Recently, *Alternaria* leaf blight is becoming increasingly important on *Kharif* and *Rabi*-summer groundnut crop.

Management of pests and diseases are important to save crop from losses and thereby increase farmer's income. Crop protection technologies generated through AICRP-Groundnut for the management insect-pests and diseases are compiled in this bulletin.

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A. TECHNOLOGIES FOR INSECT-PEST MANAGEMENT

1. DEFOLIATOR PEST MANAGEMENT IN GROUNDNUT USING BOTANICAL OILS (Andhra Pradesh, Karnataka and Tamil Nadu)

Name of the technology	:	Botanical oils for management of defoliator pests in groundnut
Details of the technology	:	Foliar spray of Karanj (Pongamia) oil @ 3 mL/L or Azadirachtin 3% @ 3 mL/L or Neem oil @ 3 mL/L or tank mixing of Karanj oil and Neem oil each @ 1.5 mL/L for managing defoliator pests
Target pest/disease	:	Defoliator pests *viz*. Tobacco caterpillar (*Spodoptera litura*), Gram pod borer (*Helicoverpa armigera*) and Leaf miner *(Aproaerema modicella*)
When and how to apply	:	• Foliar spray when, defoliation or mines caused by insects exceeds Economic Threshold Level (25% defoliation at vegetative stage or 5-mines per plant at 30 days after sowing) • Need based second foliar spray at 15-days interval
	Note :	Spray volume of water required is 500 L/ha
Technology recommended for	:	Andhra Pradesh, Karnataka and Tamil Nadu
Technology validated at	:	ANGRAU (ARS-Kadiri), UAS-R (MARS-Raichur) and TNAU (RRS-Vriddhachalam) centres of AICRP-G
Technology validation period	:	*Kharif* 2016 to *Kharif* 2018
Technology release year and place	:	2019, Annual Group Meeting of AICRP-G held at AU, Vishakhapatnam

Tobacco caterpillar

Gram pod borer

Groundnut leaf miner

2. DEFOLIATOR PEST MANAGEMENT IN GROUNDNUT USING NEW INSECTICIDE MOLECULES (Karnataka, Tamil Nadu and Telangana)

Name of the technology	:	New insecticide molecules for management of defoliator pests in groundnut
Details of the technology	:	Single foliar spray of Chlorantraniliprole 18.5SC @ 125 mL/ha or Flubendiamide 39.35SC @ 100 mL/ha or Novaluron 10EC @ 500 mL/ha
Target pest/disease	:	Defoliator pests *viz*. Tobacco caterpillar (*Spodoptera litura*) and Gram pod borer (*Helicoverpa armigera*)
When and how to apply	:	Foliar spray when, defoliation caused by insects exceeds Economic Threshold Level (25% defoliation at vegetative stage)
	Note :	Spray volume of water required is 500 L/ha
Technology recommended for	:	Karnataka, Tamil Nadu and Telangana
Technology validated at	:	UAS-D (MARS-Dharwad), TNAU (RRS-Vriddhachalam) and ANGRAU (RARS-Jagtial) centres of AICRP-G
Technology validation period	:	*Rabi*-summer 2011 to *Kharif* 2012
Technology release year and place	:	2013, Annual Group Meeting of AICRP-G held at JAU, Junagadh

Defoliated plants

Tobacco caterpillar moth

Gram pod borer moth

3. LEAF MINER MANAGEMENT IN GROUNDNUT USING INSECTICIDES (Karnataka and Tamil Nadu)

Name of the technology	:	Insecticides for management of leaf miner in groundnut
Details of the technology	:	Single foliar spray of Profenophos 50EC @ 1000 mL/ha or Spinosad 45SC @ 150 mL/ha or Flubendiamide 39.35SC @ 75-100 mL/ha or Quinalphos 25EC @ 1000 mL/ha
Target pest/disease	:	Leaf miner *(Aproarema modicella)*
When and how to apply	:	Foliar spray when, mines caused by insects exceeds Economic Threshold Level (5-mines per plant at 30 days after sowing)
	Note :	Spray volume of water required is 500 L/ha
Technology recommended for	:	Karnataka and Tamil Nadu
Technology validated at	:	UAS-R (MARS-Raichur) and TNAU (RRS-Vriddhachalam) centres of AICRP-G
Technology validation period	:	*Rabi*-summer 2011 to *Kharif* 2012
Technology release year and place	:	2013, Annual Group Meeting of AICRP-G held at JAU, Junagadh

Leaf miner pupae

Leaf miner moth

Leaf miner infested plants

4. SUCKING PEST MANAGEMENT IN GROUNDNUT USING SEED TREATMENTS (Andhra Pradesh, Gujarat, Karnataka, Maharashtra, Tamil Nadu and Telangana)

Name of the technology	:	Seed treatments for management of sucking pests of groundnut
Details of the technology	:	Seed treatment with Imidacloprid 48FS or Thiamethoxam 30FS @ 2 mL/kg seed (1:3 ratio of chemical and water) reduces sucking pest incidence and protects the crop
Target pest/disease	:	Sucking pests *viz*. Thrips (*Frankliniella schultzei*, *Thrips tabaci*, *Thrips palmi* and *Scirtothrips dorsalis*) and Leafhoppers (*Empoasca kerri* and *Balclutha hortensis*)
When and how to apply	:	Seed treatment must be done prior to sowing
Note	:	1 part of insecticide to be diluted with 3 parts of water
Technology recommended for	:	Andhra Pradesh, Gujarat, Karnataka, Maharashtra, Tamil Nadu and Telangana
Technology validated at	:	ANGRAU (ARS-Kadiri and RARS-Tirupati), JAU (MORS-Junagadh), UAS-D (MARS-Dharwad), UAS-R (MARS-Raichur), MPKV (ORS-Jalgaon), VNMKV (ORS-Latur), TNAU (RRS-Vriddhachalam) and PJTSAU (RARS-Jagtial) centres of AICRP-G
Technology validation period	:	*Kharif* 2013 to *Kharif* 2015
Technology release year and place	:	2016, Annual Group Meeting of AICRP-G held at JAU, Junagadh

Thrips (inset: closeup picture)

Leafhopper

5. SUCKING PEST MANAGEMENT IN GROUNDNUT USING NEONICOTINOID INSECTICIDES (Andhra Pradesh, Gujarat, Karnataka and Telangana)

Name of the technology	:	Neonicotinoid insecticides for management of sucking pests of groundnut
Details of the technology	:	Single foliar spray of Imidacloprid 17.8SL @ 150 mL/ha or Thiacloprid 480SC @ 125 mL/ha or Thiomethoxam 25WG @ 100 g/ha or Acetamiprid 20SP @ 100 g/ha
Target pest/disease	:	Sucking pests *viz*. Thrips (*Frankliniella schultzei*, *Thrips tabaci*, *Thrips palmi* and *Scirtothrips dorsalis*) and Leafhoppers (*Empoasca kerri* and *Balclutha hortensis*)
When and how to apply	:	Foliar spray between 25 and 30 days after sowing
Note	:	Spray volume of water required is 500 L/ha. In case of unavailability of Thiacloprid 480SC, Thiacloprid 21.7SC may be used
Technology recommended for	:	Andhra Pradesh, Gujarat, Karnataka and Telangana
Technology validated at	:	ANGRAU (ARS-Kadiri and RARS-Jagtial) JAU (MORS-Junagadh) and UAS-D (MARS -Dharwad) centres of AICRP-G
Technology validation period	:	*Rabi*-summer 2011 to *Rabi*-summer 2012
Technology release year and place	:	2013, Annual Group Meeting of AICRP-G held at JAU, Junagadh

Silvery white patches on leaves due to Thrips

V-shaped yellowing in leaves due to Leafhopper

6. WHITE GRUBS MANAGEMENT IN GROUNDNUT USING SEED TREATMENT (Gujarat and Karnataka)

Name of the technology	:	Seed treatments for management of White grubs in groundnut
Details of the technology	:	Seed treatment with Chlorpyriphos 20EC @ 12 mL/kg or Imidacloprid 48FS @ 2 mL/kg of seed for managing White grubs
Target pest/disease	:	White grubs (*Holotrichia* sp. and *Anomala* sp.)
When and how to apply	:	Seed treatment must be done prior to sowing
Note	:	Insecticide to be diluted in water appropriately to cover seed coat
Technology recommended for	:	Gujarat and Karnataka
Technology validated at	:	JAU (MORS-Junagadh) and UAS-D (MARS-Dharwad) centres of AICRP-G
Technology validation period	:	*Kharif* 2016 to *Kharif* 2018
Technology release year and place	:	2019, Annual Group Meeting of AICRP-G held at AU, Vishakhapatnam

White grubs infested field

White grubs

White grub beetle

7. BRUCHID MANAGEMENT IN GROUNDNUT BY DISINFECTING STORAGE BAGS (Andhra Pradesh and Karnataka)

Name of the technology	:	Disinfecting storage bags for Bruchid management in groundnut
Details of the technology	:	Disinfesting jute bags with Deltamethrin 2.5SC @ 0.5 mL/L protects groundnut pods from Bruchid infestation for six months of storage
Target pest/disease	:	Groundnut bruchid (*Caryedon serratus*)
When and how to apply	:	Bags must be soaked in insecticide solution for 10 min and then shade dried, prior to storing groundnuts
	Note :	In case of unavailability of Deltamethrin 2.5SC, Deltamethrin 2.5WP may be used
Technology recommended for	:	Andhra Pradesh and Karnataka
Technology validated at	:	ANGRAU (ARS-Kadiri) and UAS-D (MARS-Dharwad) centres of AICRP-G
Technology validation period	:	*Kharif* 2013 to *Kharif* 2015
Technology release year and place	:	2016, Annual Group Meeting of AICRP-G held at JAU, Junagadh

Bruchid eggs on pod

Bruchid grubs and cocoons

Bruchid beetle

B. TECHNOLOGIES FOR DISEASE MANAGEMENT

1. SOIL-BORNE DISEASE MANAGEMENT IN GROUNDNUT WITH INTEGRATION OF PRACTICES (Andhra Pradesh and Rajasthan)

Name of the technology	:	Integrated soil-borne disease management in groundnut
Details of the technology	:	Seed treatment with Tebuconazole 2DS @ 1.5 g/kg of seeds with furrow application of *Trichoderma viride* @ 4 kg enriched in 250 kg FYM/ha
Target pest/disease	:	Soil-borne diseases (Stem rot, Collar rot and Dry root rot)
When and how to apply	:	• Seed treatment must be done prior to sowing • Furrow application at the time of sowing
Technology recommended for	:	Andhra Pradesh and Rajasthan
Technology validated at	:	ANGRAU (ARS-Kadiri) and SKRAU (ARSS-Hanumangarh) centres of AICRP-G
Technology validation period	:	*Kharif* 2013 to *Kharif* 2015
Technology release year and place	:	2016, Annual Group Meeting of AICRP-G held at JAU, Junagadh

Stem rot affected field

Collar rot infected seed

Dry root rot affected plant

2. SOIL-BORNE DISEASE MANAGEMENT IN GROUNDNUT WITH INTEGRATION OF PRACTICES (Andhra Pradesh, Karnataka, Maharashtra and Tamil Nadu)

Name of the technology	:	Integrated soil-borne disease management in groundnut
Details of the technology	:	Deep summer ploughing with mouldboard plough, then soil application of *Trichoderma* sp. @ 4 kg/ha enriched in 250 kg FYM/ha as basal (furrow) application, then seed treatment with Tebuconazole 2DS @ 1.5 g/kg seed followed by PGPR @ 625 g/ha of seed, then again soil application (broadcasting) of *Trichoderma* sp. @ 4 kg/ha enriched in 250 kg FYM/ha at 35 and 70 days after sowing
Target pest/disease	:	Soil-borne diseases *viz*. Stem rot, Collar rot and Dry root rot
When and how to apply	:	• Prepare land in summer using mouldboard plough • Seed treatment must be done prior to sowing • Furrow application at the time of sowing • Broadcasting at 35 and 70 days after sowing
Technology recommended for	:	Andhra Pradesh, Karnataka, Maharashtra and Tamil Nadu
Technology validated at	:	ANGRAU (ARS-Kadiri), UAS-R (MARS-Raichur), MPKV (ORS-Jalgaon) and TNAU (CRS-Aliyarnagar and RRS-Vriddhachalam) centres of AICRP-G
Technology validation period	:	*Kharif* 2015 to *Kharif* 2017
Technology release year and place	:	2018, Annual Group Meeting of AICRP-G held at PJTSAU, Hyderabad

Brown sclerotia of *S. rolfsii*

Sporulation in Collar rot affected plant

3. FOLIAR DISEASE MANAGEMENT MODULE FOR GROUNDNUT (Karnataka, Gujarat and Tamil Nadu)

Name of the technology	:	Module for foliar disease management in groundnut
Details of the technology	:	Seed treatment with Tebuconazole 2DS @ 1.5 g/kg seeds followed by two foliar sprays of Tebuconazole 50% + Trifloxystobin 25%-75WG @ 1.32 g/L at 40 and 65 days after sowing
Target pest/disease	:	Foliar diseases *viz*. Late leaf spot, Rust and *Alternaria* leaf blight
When and how to apply	:	• Seed treatment must be done prior to sowing • Foliar sprays at 40 and 65 days after sowing
Note	:	Spray volume of water required is 500 L/ha
Technology recommended for	:	Karnataka, Gujarat and Tamil Nadu
Technology validated at	:	UAS-B (ARS-Pavagada), UAS-D (MARS-Dharwad), UAS-R (MARS-Raichur), JAU (MORS-Junagadh) and TNAU (RRS-Vriddhachalam) centres of AICRP-G
Technology validation period	:	• *Rabi*-summer 2016 to *Rabi*-summer 2019 • *Kharif* 2016 to *Kharif* 2018
Technology release year and place	:	• 2020, Annual Group Meeting of AICRP-G held *via* video conferencing at ICAR-DGR, Junagadh • 2019, Annual Group Meeting of AICRP-G held at AU, Vishakhapatnam

Rust affected plants

***Alternaria* leaf blight affected plants**

4. FOLIAR DISEASE MANAGEMENT IN GROUNDNUT WITH FUNGICIDE SPRAY APPLICATION (Maharashtra and Tamil Nadu)

Name of the technology	:	Fungicide spray application for foliar disease management in groundnut
Details of the technology	:	Two foliar spray applications of Tebuconazole 25.9EC @ 1 mL/L at 40 and 65 days after sowing
Target pest/disease	:	Foliar diseases *viz.* Late leaf spot and Rust
When and how to apply	:	Foliar sprays at 40 and 65 days after sowing
Note	:	Spray volume of water required is 500 L/ha
Technology recommended for	:	Maharashtra and Tamil Nadu
Technology validated at	:	MPKV (ORS-Jalgaon) and TNAU (CRS-Aliyarnagar) centres of AICRP-G
Technology validation period	:	*Rabi*-summer 2017 to *Rabi*-summer 2019
Technology release year and place	:	2020, Annual Group Meeting of AICRP-G held *via* video conferencing at ICAR-DGR, Junagadh

Late leaf spot

Orange color pustules of Rust

5. FOLIAR DISEASE MANAGEMENT MODULE FOR GROUNDNUT (Andhra Pradesh, Maharashtra and Tamil Nadu)

Name of the technology	:	Module for foliar disease management in groundnut
Details of the technology	:	Seed treatment with Tebuconazole 2DS @ 1.5 g/kg seeds followed by foliar spray of Tebuconazole 25.9EC @ 1 mL/L at 40 and 65 days after sowing
Target pest/disease	:	Foliar diseases *viz*. Early leaf spot, Late leaf spot, Rust and *Alternaria* leaf blight
When and how to apply	:	• Seed treatment must be done prior to sowing • Foliar sprays at 40 and 65 days after sowing
Note	:	Spray volume of water required is 500 L/ha
Technology recommended for	:	Andhra Pradesh, Maharashtra and Tamil Nadu
Technology validated at	:	ANGRAU (ARS-Kadiri), MPKV (ORS-Jalgaon) and TNAU (CRS-Aliyarnagar) centres of AICRP-G
Technology validation period	:	*Kharif* 2016 to *Kharif* 2018
Technology release year and place	:	2019, Annual Group Meeting of AICRP-G held at AU, Vishakhapatnam

Early leaf spot

***Alternaria* leaf blight**

6. FOLIAR DISEASE MANAGEMENT MODULE FOR GROUNDNUT (Gujarat, Karnataka and Tamil Nadu)

Name of the technology	:	Management module for foliar diseases in groundnut
Details of the technology	:	Seed treatment with Tebuconazole 2DS @ 1.5 g/kg followed by furrow application of *Trichoderma viride* @ 4 kg enriched in 250 kg FYM/ha as basal application, then broadcasting of *T. viride* @ 4 kg enriched in 250 kg FYM/ha at 40 days after sowing and two foliar sprays of Tebuconazole 29.5EC @ 1 mL/L, starting from initiation of foliar diseases and second spray at 15 days interval
Target pest/disease	:	Leaf spots (Early leaf spot and Late leaf spot) and Rust
When and how to apply	:	• Seed treatment must be done prior to sowing • Furrow application at the time of sowing • Broadcasting at 40 days after sowing • First foliar spray at the initiation of foliar diseases followed by second foliar spray at 15-days interval
Note	:	Fungicide to be diluted in water appropriately to cover seed coat. Spray volume of water and required is 500 L/ha
Technology recommended for	:	Gujarat, Karnataka and Tamil Nadu
Technology validated at	:	JAU (MORS-Junagadh), UAS-D (MARS-Dharwad) and TNAU (CRS-Aliyarnagar) centres of AICRP-G
Technology validation period	:	*Kharif* 2013 to *Kharif* 2015
Technology release year and place	:	2016, Annual Group Meeting of AICRP-G held at JAU, Junagadh

***Tikka* (Early and Late leaf spot)**

Leaf spots and Rust affected leaves

7. FOLIAR DISEASE MANAGEMENT MODULE FOR GROUNDNUT (Andhra Pradesh, Karnataka, Maharashtra, Odisha and Tamil Nadu)

Name of the technology	:	Management module for foliar diseases in groundnut
Details of the technology	:	● Seed treatment with Tebuconazole 2DS @ 1.5 g/kg followed by two foliar spray of Tebuconazole 25.9EC @ 1 mL/L at 45 and 60 days after sowing OR ● Seed treatment with Mancozeb 80WP @ 3 g/kg followed by two foliar spray of Hexaconazole 5EC @ 1 mL/L at 45 and 60 days after sowing
Target pest/disease	:	Foliar diseases *viz.* Late leaf spot and Rust
When and how to apply	:	● Seed treatment must be done prior to sowing ● Foliar sprays at 45 and 60 days after sowing
Note	:	Spray volume of water required is 500 L/ha. In case of unavailability of Mancozeb 80WP, Mancozeb 75WP may be used
Technology recommended for	:	Andhra Pradesh, Karnataka, Maharashtra, Odisha and Tamil Nadu
Technology validated at	:	ANGRAU (ARS-Kadiri), UAS-D (MARS-Dharwad), UAS-R (MARS-Raichur), MPKV (ORS-Jalgaon), VNMKV (ORS-Latur), OUAT (DOS-Bhubaneswar) and TNAU (CRS-Aliyarnagar and RRS-Vriddhachalam) centres of AICRP-G
Technology validation period	:	*Kharif* 2010 to *Kharif* 2012
Technology release year and place	:	2013, Annual Group Meeting of AICRP-G held at JAU, Junagadh

Leaf spots and Rust

Leaf spots and Rust affected field

8. DISEASE MANAGEMENT IN ORGANIC GROUNDNUT WITH *TRICHODERMA* (Andhra Pradesh, Rajasthan and Tamil Nadu)

Name of the technology	:	*Trichoderma* application for disease management in organic groundnut
Details of the technology	:	Seed treatment with *Trichoderma* sp. @ 10 g/kg of seed followed by soil application of *Trichoderma* sp. @ 4 kg enriched with 250 kg FYM and foliar spray of neem seed kernel extract at 5%
Target pest/disease	:	Soil-borne diseases (Stem rot, Collar rot and Dry root rot) and foliar diseases (Late leaf spot and Rust)
When and how to apply	:	• Seed treatment must be done prior to sowing • Furrow application at the time of sowing • Foliar spray at 30 and 45 days after sowing
	Note :	Spray volume of water required is 500 L/ha
Technology recommended for	:	Andhra Pradesh, Rajasthan and Tamil Nadu
Technology validated at	:	ANGRAU (ARS-Kadiri), SKRAU (ARSS-Hanumangarh) and TNAU (CRS-Aliyarnagar) centres of AICRP-G
Technology validation period	:	*Kharif* 2013 to *Kharif* 2015
Technology release year and place	:	2016, Annual Group Meeting of AICRP-G held at JAU, Junagadh

Pod rot by *S. rolfsii*

Collar rot affected plants

9. DISEASE MANAGEMENT IN ORGANIC GROUNDNUT WITH *TRICHODERMA* AND *PSEUDOMONAS* (Karnataka, Maharashtra and Odisha)

Name of the technology	:	*Trichoderma* and *Pseudomonas* application for disease management in organic groundnut
Details of the technology	:	Seed treatment with *Trichoderma* sp. (10 g) and *Pseudomonas fluorescens* (10 g) per kg seed followed by furrow application of *Trichoderma* sp. (2 kg) and *P. fluorescens* (2 kg) enriched FYM at 250 kg/ha and foliar spray of *Trichoderma* sp. (2.5 kg) and *P. fluorescens* (2.5 kg) per hectare
Target pest/disease	:	Soil-borne diseases (Stem rot, Collar rot and Dry root rot) and foliar diseases (Late leaf spot and Rust)
When and how to apply	:	• Seed treatment must be done prior to sowing • Furrow application at the time of sowing • Foliar sprays at 30 and 45 days after sowing
Note	:	Spray volume of water required is 500 L/ha
Technology recommended for	:	Karnataka, Maharashtra and Odisha
Technology validated at	:	UAS-R (MARS-Raichur), MPKV (ORS-Jalgaon) and OUAT (DOS-Bhubaneswar) centres of AICRP-G
Technology validation period	:	*Kharif* 2013 to *Kharif* 2015
Technology release year and place	:	2016, Annual Group Meeting of AICRP-G held at JAU, Junagadh

Dry root rot affected tap root system

White mycelial growth of *S. rolfsii*

10. PEANUT BUD NECROSIS DISEASE MANAGEMENT MODULE FOR GROUNDNUT (Andhra Pradesh, Karnataka and Maharashtra)

Name of the technology	:	Management module for Peanut Bud Necrosis Disease in groundnut
Details of the technology	:	Growing border crop with *jowar* (4 rows), high seed rate (200 kg/ha) of groundnut treated with Imidacloprid 48FS @ 1 mL/kg seed followed by foliar sprays of Thiacloprid 480SC @ 0.3 mL/L at 20 days after sowing and Fipronil 5SC @ 1 mL/L at 35-40 days after sowing
Target pest/disease	:	Thrips (*Frankliniella schultzei*, *Thrips palmi* and *Scirtothrips dorsalis*) and PBND (*Peanut Bud Necrosis Virus*)
When and how to apply	:	• Seed treatment must be done prior to sowing • High density planting with high seed rate • Sow *jowar* in border rows at sowing of groundnut foliar sprays at 20 and 35-40 days after sowing
	Note :	Insecticide to be diluted in water appropriately to cover seed coat. Spray volume of water required is 500 L/ha. In case of unavailability of Thiacloprid 480SC, Thiacloprid 21.7SC may be used
Technology recommended for	:	Andhra Pradesh, Karnataka and Maharashtra
Technology validated at	:	ANGRAU (ARS-Kadiri), UAS-R (MARS-Raichur) and VNMKV (ORS-Latur) centres of AICRP-G
Technology validation period	:	*Kharif* 2013 to *Kharif* 2015
Technology release year and place	:	2016, Annual Group Meeting of AICRP-G held at JAU, Junagadh

Browning of lower side due to Thrips

Peanut Bud Necrosis Disease

11. INTEGRATED PEST AND DISEASE MANAGEMENT MODULE FOR GROUNDNUT (Karnataka)

Name of the technology	:	IPDM module for insect-pests and diseases of groundnut
Details of the technology	:	Seed treatment with Tebuconazole 2DS @ 1.5 g/kg seed + Border crop with *bajra* (3 or 4 rows) + Need based foliar spray of Thiodicarb 75WP @ 1 g/L between 50-70 days after sowing for defoliator pests + Need based foliar spray of Hexaconazole 5EC @ 1 mL/L between 50-70 days after sowing for foliar diseases
Target pest/disease	:	Insect-pests (Thrips, Leafhoppers, Tobacco caterpillar and Leaf miner) and Diseases (Early leaf spot and Late leaf spot, Rust, Stem rot, Collar rot and Dry root rot)
When and how to apply	:	● Seed treatment to be done prior to sowing ● Sow *bajra* in border rows at sowing of groundnut ● Foliar sprays between 50-70 days after sowing
	Note :	Fungicide to be diluted in water appropriately to cover seed coat. Spray volume of water and required is 500 L/ha
Technology recommended for	:	Karnataka
Technology validated at	:	UAS-D (MARS-Dharwad) and UAS-R (MARS -Raichur) centres of AICRP-G
Technology validation period	:	*Kharif* 2016 to *Kharif* 2018
Technology release year and place	:	2019, Annual Group Meeting of AICRP-G held at AU, Vishakhapatnam

Egg mass of Tobacco caterpillar

Tobacco caterpillar

12. INTEGRATED PEST AND DISEASE MANAGEMENT MODULE FOR GROUNDNUT (Andhra Pradesh and Gujarat)

Name of the technology	:	IPDM module for insect-pests and diseases of groundnut
Details of the technology	:	Seed treatment with *Trichoderma* sp. @ 10 g/kg seed, need based foliar spray of Imidacloprid 17.8SL @ 0.3 mL/L at 30 days after sowing followed by need based spray of Novaluron 10EC @ 1 mL/L between 50-70 days after sowing for defoliator pests and need based spray of Tebuconazole 25.9EC @ 1.5 mL/L between 50-70 days after sowingz for foliar diseases
Target pest/disease	:	Insect-pests (Thrips, Leafhoppers, Tobacco caterpillar and Leaf miner) and Diseases (Early leaf spot, Late leaf spot, Rust, Stem rot, Collar rot and Dry root rot)
When and how to apply	:	• Seed treatment must be done prior to sowing • Foliar sprays between 50-70 days after sowing
Note	:	Spray volume of water required is 500 L/ha
Technology recommended for	:	Andhra Pradesh and Gujarat
Technology validated at	:	ANGRAU (ARS-Kadiri) and JAU (MORS-Junagadh) centres of AICRP-G
Technology validation period	:	*Kharif* 2016 to *Kharif* 2018
Technology release year and place	:	2019, Annual Group Meeting of AICRP-G held at AU, Vishakhapatnam

Leaf spot and Rust

Gram pod borer

Contributors (A-Z): Adiver SS, Arunkumar H, Bapodara JG, Bharadiya AM, Chandrayudu E, Chaudhary GB, Deore PB, Deshmukh GP, Devaki K, Dhal A, Dighule SB, Gaikwad RT, Gawade SB, Gururaj Sunkad, Harish G[6], Hegde MG, Indiragandhi P, Jadon KS[7], Jahir Basha CR, Jayewar NE, Kapadiya HJ, Karthikeyan A, Karunanithi K, Kelaiya DS, Kennedy JS[3], Khanpara DV, Kumhar DR, Lukose C[4], Mallesh SB, Mallikarjun K, Meena AK, Misra JB[1], Moradia A, Motaka MN, Muralikrishna T, Mutkule DS, Nagaraju P, Nataraja MV[6], Nathawat BDS, Pal KK[5], Patel PV, Poonam Jasrotia[3,6], Radhakishanan T[1], Ram Dutta[2], Rathnakumar AL[5], Rohini S, Rupak Jena, Senapati AK, Senthilraja G, Sheela J, Shirke MS, Shirshikar SP, Shreevani GN, Sivaramakrishna M, Somasekhar B, Srianant Kurella, Sreedevi SC, Sundravadana S, Suryawanshi JS, Thirumalaisamy PP[7], Tippannavar PS, Ushamalini C, Vemana K, Venkataiah M and Venkateswarlu NC. Management components including pesticides included in the technical bulletin were thoroughly discussed in the Annual Group Meeting of respective years and the same were executed at the AICRP-G centres. Due credit of contribution of principal investigators/co-principal investigators, scientists, during their period of association with the AICRP-G Crop Protection, in the generation of technologies from the respective disciplines, included in this bulletin, is duly acknowledged. *[1]Project coordinator; [2]PI-Crop Protection;[3]PI-Entomology; [4]PI-Plant Pathology; [5]Nodal Scientist; [6]Co-PI-Entomology and [7]Co-PI-Plant Pathology.*

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