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MANUAL FOR PIGEONPEA PEST SURVEILLANCE

National Initiative on Climate Resilient Agriculture



National Centre for Integrated Pest Management, New Delhi
Central Research Institute for Dryland Agriculture, Hyderabad
Indian Institute of Pulses Research, Kanpur

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ICAR, New Delhi
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Hyderabad
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Foreword

Indian Council of Agricultural Research (ICAR) launched the National Initiative on Climate Resilient Agriculture (NICRA) during 2010-11 with three pronged objectives of strategic research, technology demonstrations and capacity building. Assessment of the impact of climate change simultaneous with formulation of adaptive strategies is the major focal point across all sectors of agriculture, dairying and fisheries. Evolving climate resilient agricultural technologies that would increase farm production and productivity *vis-à-vis* continuous management of natural and manmade resources constitute an integral part of sustaining agriculture in the era of climate change.

Plant protection deserves prime importance in crop production because of the fact that potential yields of crops are limited by pest groups of various categories *viz.*, insects, diseases, weeds, nematodes and rodents. Since pests are biotic natural resources of earth, their interdependent interactions amongst system variables are equally influenced by the factors of climate change. Climatic effects on pests could be direct as well as crop mediated. NICRA recognized the importance of pest risks associated with climate change and provided a research platform across crops of rice, **pigeonpea**, groundnut, tomato and mango during its first phase of implementation under eleventh plan. Assessing the changing pest scenario, mapping of vulnerable regions of pest risks and to evolve preventive as well as curative pest management strategies as adaptation towards climatic stress have been emphasized among many approaches to study of climate change impact on pests. The long term trend analysis of their association with climate is important. Most often the available historical data lack continuity and their holistic retrieval is cumbersome. Availability of information technological tools has made it possible to create centralized database of desired resources and associated activities with ease, in turn making scientific analyses and inferences more meaningful.

In case of studies relating to pest dynamics, it is essential to streamline methods of surveillance through carefully designed data recording formats relating to crops, pests, and production and protection practices in addition to weather. Implementation of pest surveillance across ten different pigeonpea growing agro ecologies under NICRA offers *per se* heterogeneity of climate, upon comparison helps to draw the underlying mechanism of the observed pest status. Analyses with weather would further aid in delineating climate effects on pests. Making pest surveillance operational through provision of pest scouts and data entry operators render it possible to capture quality data at field level guided by scientific staff.

Preparation of “Manual for Pigeonpea Pest Surveillance” has been a part of systematic attempt to give specific skills to the users to undertake sampling relating to pigeonpea pests. I appreciate the team work of the pigeonpea plant protection specialists of the nation, and wish that the research outcome would be useful for the present and future of pigeonpea pest management.



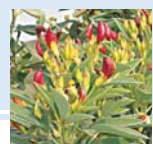
(Dr. A. K. Singh)

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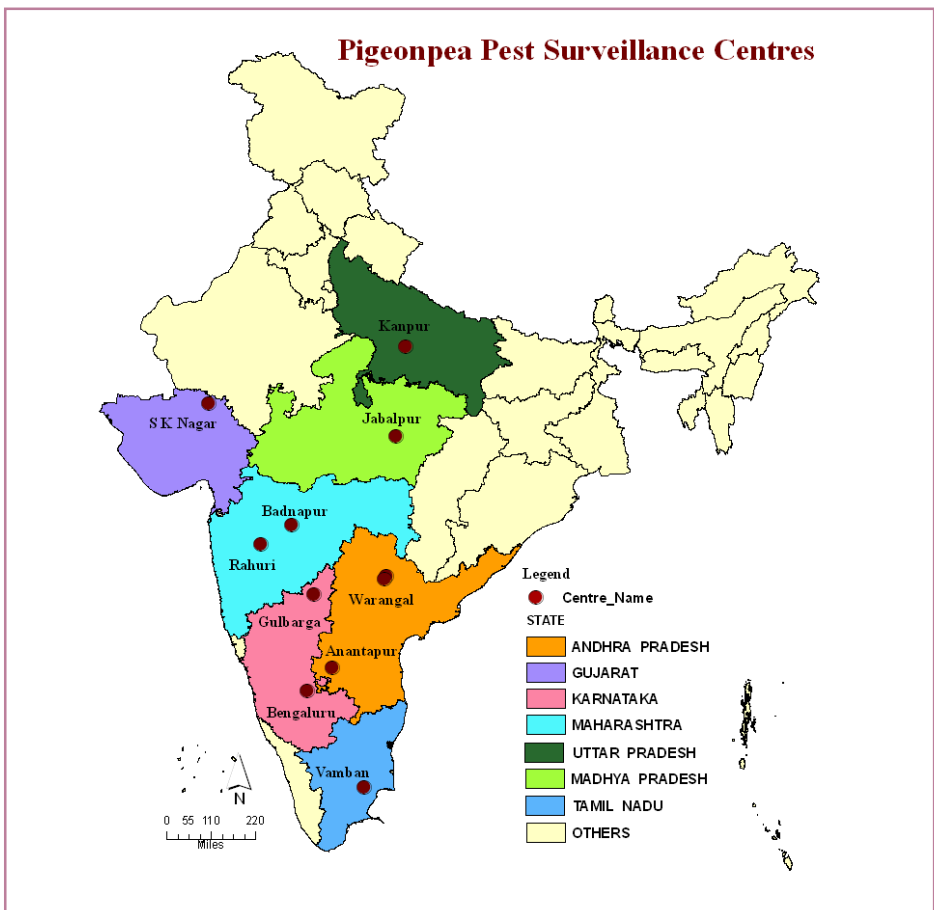
1. Introduction

Pigeonpea (*Cajanus cajan* (L.) Millsp.) is one of the most important legume crops of the tropics and subtropics of Asia and Africa. Pigeonpea, also known by names such as redgram, arhar and tur in India, offers nutritional security due to its richness in protein (21%) along with mineral supplements *viz.*, iron and iodine. India is the world's largest producer and consumer of pulses including pigeonpea. About 90% of the global pigeonpea area (4.9 M.ha.) is in India contributing to 93% of the global production. Maharashtra, Uttar Pradesh, Madhya Pradesh, Karnataka, Gujarat, Andhra Pradesh, Tamil Nadu and Bihar are the major growing States of our country. Chhattisgarh, Rajasthan, Odisha, Punjab and Haryana also grow the crop but in lesser area. India with its area of 3.75 million hectares produces 3.1 million tonnes with its productivity ranking ninth in the world. The productivity levels range from 360 to 1145 kg/ha owing to the cultivation of the crop on a wide range of soils in different cropping systems across varied agro climatic regions. Crop's ability to resist drought and to add large quantities of biomass to the soil in addition to nitrogen fixation makes it a good choice for rainfed as well irrigated production systems. *Kharif* is the growing season of pigeonpea in India. Moisture stress and sudden drop in temperature coupled with frost and foggy weather during the pod development stage, and terminal drought cause yield reduction leading to instability in production. In the context of climate change, it has been revealed that legumes, in general and pigeonpea, in particular have the potential to maximize the benefit of elevated CO₂ arising out of climate change effects by matching stimulated photosynthesis with increased nitrogen fixation. Such a positive result illustrates the importance of pigeonpea as a crop of sustained supporter of food and nutritional security under the climate change scenarios.

Limitation to the increasing productivity of pigeonpea is also due to biotic stresses prevalent across the pulse growing regions. Among biotic stresses diseases *viz.*, wilt, sterility mosaic and foliar diseases and insect pests feeding on pods lead to significant yield losses. Climate change is expected to trigger changes in diversity and abundance of arthropods, geographical and temporal distribution of insect pests, insect biotypes, herbivore plant interactions, activity and abundance of natural enemies, and efficacy of crop protection technologies. We expect both the crop in terms of phenology and physiology and the pests in their occurrence and abundance likely to change. Study of impact of climate change on pigeonpea crop-pest interactions requires carefully collected data on long term basis. While already available historical data could form an approach for partial study of climate change impacts, formulation and implementation of a robust research strategy combining the present scenario of cropping patterns, cultivars, and production and protection

practices across heterogeneous locations over time would yield improved and holistic understanding. Considering the importance of the pigeonpea grown across Indian cropping systems as a pulse crop and its associated role in food and nutritional security, “National Initiative on Climate Resilient Agriculture” (NICRA) provided thrust to improve the productivity level of the crop through assessment of the changing pest dynamics in relation to climate, and through development of forewarning models.

A plan to study of dynamics of pigeonpea pests in multiple locations over seasons along with other system components including weather was formulated to be implemented through surveillance integrating geographical, field, crop, agronomical and pest management practices. During the eleventh plan, ten research centers (refer map) located across seven States representing dominant pigeonpea growing climatic zones have been included under NICRA for pest surveillance.





Pre requisite for such a surveillance is to devise a plan followed by design of data recording formats suiting to the purpose. The consultative group meeting of the participating researchers of pigeonpea under NICRA finalized the structural plan of pest surveillance to be carried out in pigeonpea fields at the research/experimental station of the identified centre, and at villages in the farmers' fields.

This manual presents the procedures to be followed towards selection of fields for surveillance at the experimental/research stations, and at villages besides the methods to be adopted for recording the observation of pests using the data recording formats finalized. The manual also describes the identification details of the insect pests and diseases for surveillance in their order given in the data sheet formats.

2. Surveillance plan and procedures

Two pigeonpea fields each at the experimental station, and in ten selected villages of the region are to be fixed for pest surveillance. Fixed fields are those fields grown with pigeonpea, that once selected should be continuously monitored year round on weekly basis for pests and diseases using the specified data sheet formats. In addition, a random survey covering eight fields @ one per village among villages other than the ten selected villages for fixed surveillance has to be done once a week. The schedule of surveillance is given as **Annexure I**. Observations in all the designated fixed fields should be made on weekly basis more or less on the days fixed for the field. Fields with sole crop of pigeonpea should be preferred for fixed field surveillance. Only under circumstances of non-availability of sole crop of pigeonpea, the intercropped fields with pigeonpea should be used for surveillance. The latitude, longitude and altitude of the surveillance village and fields should also be noted using the GPS unit.

2.1. Selection of fixed fields

Fixed fields at research station

In the research station, two experimental fields each of one acre (minimum of half an acre), should be planted with regionally popular cultivar of pigeonpea. One of the fields has to be unprotected without any plant protection measures for any of the pests on the crop (designated as Fixed 1). The other field, (designated as Fixed 2) should be protected using need based application of pesticides to keep the crop free from prevailing insect pests and diseases.

Fixed fields of farmers in villages

Select ten villages growing pigeonpea representing the agro ecology of the identified region in the same district or nearby districts. In each village, two

farmer fields (Fixed 1 and Fixed 2) each of area near to one acre (minimum of 0.5 acre) should be selected for surveillance during the season. Assigning fields of farmers as Fixed 1 and Fixed 2 should be made during the first observation of surveillance, and the same should be maintained till the end of season. Take care to select farmers growing popular pigeonpea cultivars of the region.

2.2. General information for fixed fields (Proforma 1)

The geographical, cropping system and agronomical details relating to general information should be collected once in the beginning of the season (**Annexure-II**). Details on the exact date of planting, cultivar, growing conditions, seed treatment, sowing method, spacing and cultural practices mentioned in the general information proforma should be collected. Care should be taken to fill the general information accurately. If all information cannot be gathered for fixed fields at one visit, they can be completed during the subsequent visits by meeting the farmer.

2.3. Specific guidelines for observations in fixed fields (Proforma 2)

- The recording of observations on insect pests and diseases in the selected fixed fields should be initiated with the sowing of the crop and continued till the end of the crop season .
- Fill in the details on State, field, district, taluka/block, name of the village or location along with the field number (Fixed 1 and Fixed 2), date of observation, stage of crop and crop health in the **Page 1 of Proforma 2 (Annexure III)**.
- For crop stage tick mark appropriate stage of crop at the time of surveillance *viz.*, vegetative/ first flowering/ 50% flowering/ pod setting & development/ maturity.
- For crop health, tick mark appropriate term as to excellent or good or poor based on the status of crop stand in the field relating to crop growth and development.
- In each selected field, select five spots randomly such that four are from four corners and one from the centre of the field. Five feet distance alongside of boundary in all directions of the field should be left out as buffer space to avoid border effects during pest observations.
- The spot selection for pest observations during each weekly visit should be random and it is not the fixed spots in a pigeonpea field that would be sampled continuously.



- At each spot select two plants adjacent to each other for observations relating to whole plant observations or else follow the sampling method given in the data sheet (for ready reference) or as mentioned below in respect of insects/diseases.
- Entry of data is the total for two plants unless specified (eg. coccinellids and spiders only on one plant per spot). All insect and disease recordings at each spot should be completed before moving on to next spot.

2.4. Pest observations

2.4.1. Insect pests

Leaf folder

Description

Creamy- yellow larvae are often found binding leaflets and feed within the web.



Folded terminal leaves



Larva of leaf folder

Procedure for observation

Number of larvae is to be counted by opening the webbed leaves on the plant on two plants (whole plant basis) and recorded.

Helicoverpa armigera

Description

Larval colour is varied- yellow, green, pink, orange, brown, or black with dark and light stripes on either side of body. Young larvae are small and found feeding on tender leaflets. Grown up larvae feed on developing seeds by making an entry hole on pods that is cut with clear round margins. Half portion of larval body remain outside the pod while feeding is also an important feature of *H. armigera*.



H. armigera larva on foliage



H. armigera larva on pod

Procedure for observation

Shake the plant to be sampled. Larvae falling on to the ground should be counted; Additionally number of early instar larvae present on the plant also should be counted (whole plant basis) on two plants and recorded.

Lablab pod borer

Description

Larvae are green with brown lateral stripes on the body. They feed on flower buds and green pods.



Larva of *Adisura*

Procedure for observation

Number of larvae should be counted by visual search method (on whole plant basis) on two plants and recorded.

Blue butterfly

Description

Larvae are green, oval and flat. Larvae feed on leaves, flower buds and green pods.



Blue butterfly larva on flower bud



Blue butterfly larva on pod

Procedure for observation

Number of larvae of blue butterfly should be counted by visual search method (on whole plant basis) on two plants and recorded.

Plume moth

Description

Larvae are green or brown, spindle shaped and covered with short spines and larger hairs. Larvae feed on developing seeds and feeding holes are visible on the plant.



Larva of plume moth (Brown)



Larva of plume moth (Green)

Procedure for observation

Number of plume moth larvae should be counted by visual search method (on whole plant basis) on two plants and recorded.

Maruca

Description

Webbing of tender leaves and flower buds together seen on plants indicate the possibility of *Maruca* damage. Closer view presents discoloration and shedding of flowers in the web and presence of frass. Upon opening of the webs, dull to yellow-white colour larva (e) with dark spots forming distinct series along the length of the body are seen.



Flowers damage by *Maruca*



Larva of *Maruca*

Procedure for observation

Number of webs of flowerbuds due to *Maruca* should be counted (on whole plant basis) on two plants per spot and recorded.

Blister beetle

Description

Adults are black in colour with large yellow spots and a red band across the abdomen. Number of spots varies with species. They feed on flowers.



Beetle feeding on flowers



Beetle on foliage

Procedure for observation

Blister beetles are to be counted as number of adults on two plants (whole plant basis) and recorded.

Ash/grey weevil

Description

Adults of weevil are grey in colour with black spots on their elytra. Number of spots varies with species. They feed by chewing on the margins of leaflets.



Ash weevil

Procedure for observation

Ash weevils are to be counted as number of adults present on two plants per spot and recorded.

Cow bug

Description

Adults are grey brown having thorn-like projections on the thorax. Ants are always associated with presence of cow bugs on pigeonpea plants. The bugs suck the sap from green stems.



Nymphs and adults



Adult bug

Procedure for observation

Cow bugs are to be counted as number of adults on two plants per spot and recorded.

Mealybugs

Description

Mealybugs are soft bodied insects covered with white waxy coatings. Crawlers are small and numerous found in aggregation. Leaves, stems and terminal shoots are largely infected. Ant association and sooty mould infestations are also seen. Different species of mealybugs occur. *Phenacoccus solenopsis*,

Paracoccus marginatus and *Coccidohystrix insolita* are some of the recently documented species of mealybugs on pigeonpea. Additional species of mealybugs are also common.

Mealybugs



On leaves



On inflorescence



On stem



Completely dried plant

Procedure for observation

One plant in the selected spot should be observed for infestation due to any species of mealybugs. Mealybug infestation across species is to be graded as to Grade 1/2/3/4.

where

Grade 1: scattered presence of mealybugs

Grade 2: 25% of plants covered with mealybugs

Grade 3: 50% of the plants covered with mealybugs

Grade 4: whole plant infested with mealybugs

Scales

Description

Scale insects are spherical shaped hard bodied found in colonies on the plant parts in pockets. Ants are also associated with scales.



Scale colonies on stem

Procedure for observation

One plant in the selected spot should be observed for infestation due to scales. Scale infestation across species is to be graded for severity as to Grade 1/2/3/4.

where

Grade 1: scattered presence of scales

Grade 2: 25% of plants covered with scales

Grade 3: 50% of the plants covered with scales

Grade 4: whole plant infested with scales

Pod bugs

Clavigralla - Bugs of this species are brown and furry.

Nymphs and adult of *Clavigralla*

Riptortus - *Riptortus* bugs are light brown and having white or yellow lines on lateral side of the body. These are found on several hosts.

Adult of *Riptortus*

Nezara - Bugs are dull green in colour. Adults of *Nezara* can feed on seeds through pod walls. Their feeding causes tiny depressions on the pod wall.



Adult of *Nezara*

Procedure for observation

Different species of pod bugs viz., *Clavigralla*, *Riptortus* and *Nezara* should be counted on whole plant basis by visual search method on two plants/spot and recorded separately.

2.4.2. Beneficials

Coccinellids

Description

Lady bird beetle grubs are black to grey and campodeiform with only thoracic legs. Pupae are inverted cup shaped stationary forms attached to leaf surfaces and stem. Adults are round and black headed and have brightly colored elytra with spots.



Grub and pupae



Adults

Procedure for observation

Number of immature stages (grubs and pupae) and adults of coccinellids together present on one plant per spot should be counted and recorded.



Spiders

Description

Spiders could be web spinners and jumping category. Spiders are eight legged. Pede palpi and compound eyes are well developed. Nymphs and adults resemble each other but for size.



Spiders

Procedure for observation

Number of nymphs and adults of spiders together present on one plant per spot should be counted and recorded.

2.4.3. Damage to pods

Pod damage due to *Helicoverpa armigera*

Description

A clear cut hole on the pod walls is the characteristic damage due to *Helicoverpa armigera*. More than one hole per pod is also a common symptom.



Feeding holes of *H. armigera*



Larva of *H. armigera*

Pod damage due to pod fly

Description

External symptoms on pods are not highly obvious. Small holes with whitish window are common when a mature maggot about to pupate is seen inside

the pod. Pod fly damage is also inferred through dissection of pods. Maggots feeding on seeds and puparia are seen in pods infested with podfly. More than one maggot or pupa could be seen inside a single pod.



Emergence hole of pod fly



Maggots and puparia of pod fly

Procedure for observation

Fifty developing pods should be randomly collected from the field (not more than 5 pods / plant) and examined for damage due to *H. armigera* and pod fly. Number of pods damaged due to *H. armigera* and pod fly should be counted and recorded separately. The total number of pod fly immature stages (maggots and pupa) should also to be counted together out of the 50 pods and noted.

2.4.4. Diseases

Fusarium wilt

Fusarium wilt appears on the young seedlings but highly observed during flowering and podding stage.

Symptoms

Disease symptoms resemble plants suffering from drought even with availability of plenty of soil moisture. Infected plants become yellow and then start drying. Brown or dark purple colored bands are found on the surface of stem which start from base to several feet above ground level. Drying of plants may be partial or complete.



Wilted plants due to *Fusarium* infection



Procedure for observation

Ten plants per spot should be examined for symptoms of *Fusarium* wilt. The number of *Fusarium* infected plants out of the 10 plants in a spot should be counted and recorded.

Phytophthora blight

Symptoms

Blight causes rapid wilting of plants, desiccation and upward rolling of leaflets, withering of petioles and small stems. Brown water soaked circular or irregular lesions are seen on leaves. Brown to dark brown marked lesions are seen on the stem near soil surface and on stem above ground. White-pink fungal growth appear on the blighted area under congenial weather.



Stem lesions due to *Phytophthora*

Procedure for observation

Ten plants per spot should be examined for symptoms of *Phytophthora* blight. The number of *Phytophthora* infected plants out of the 10 plants in a spot should be counted and recorded.

Sterility mosaic

Symptoms

Mosaic symptoms, reduction in leaf size and ring spots on leaflets are common. Plants present pale green and bushy appearance without flowers and pods. Sterility of plants can be partial or full. Partially sterile plants produce discolored and shrivelled seeds.



Sterility mosaic infected plants

Procedure for observation

Ten plants per spot should be examined for symptoms of sterility mosaic. The number of sterility mosaic infected plants out of the 10 plants in a spot should be counted and recorded.

Phyllody

Symptoms

Disease appears at the time of flowering. Infected plants have bushy appearance with excessive branching, shortened internodes, reduced leaf size and phylloid flowers. Sometime stamens get enlarged into leaf like structures.



Bushy terminal of phylloid plant

Procedure for observation

Ten plants per spot should be examined for symptoms of phyllody. The number of plants showing symptoms of phyllody out of the 10 plants in a spot should be counted and recorded.

Macrophomina stem canker

Symptoms

Disease causes spindle shaped lesions on the stem which may cause drying of whole of plant. The elongated to elliptical lesions are grayish white with dark brown margins. Some plants may break from the site of infection.

Procedure for observation

Ten plants per spot should be examined for symptoms of stem canker caused by *Macrophomina*. The number of plants showing symptoms of stem canker out of the 10 plants in a spot should be counted and recorded.

Alternaria blight

Symptoms

Disease appears in the form of light to dark brown small necrotic spots on the leaves and pods. Severe infections cause defoliation and destruction of crop. Disease is mostly confined to older leaves but may infect new leaves in post rainy season.



Necrotic spot due to *Alternaria*



Procedure for observation

The intensity of the disease should be recorded based on the ratings given alongside of data recording table in the proforma. The severity rating for five individual plants randomly selected in the field should be recorded. The severity rating scale of the disease is given below.

Disease rating scale for *Alternaria* blight

Scale	Description
0	No symptoms
1	1-10% of plants infected
2	11-25% of plants infected
3	26-50% of plants infected
4	51-75% of plants infected
5	75-100% of plants infected

Powdery mildew

Symptoms

Disease often found on leaves flower buds also get infected under favorable weather conditions. Severe infection cause yellowing of leaves with crinkling. White powdery patches are found on both surfaces. Defoliation can also occur.



Powdery mildew infected leaves

Procedure for observation

The intensity of the disease should be recorded based on the ratings given alongside of data table. The severity rating for five individual plants randomly selected in a field should be recorded. The severity rating scale of the disease is also furnished here under.

Disease rating scale for powdery mildew

Scale	Description
0	No infection
1	Trace to <5% infection of a plant
3	>10-25% infection of a plant
5	>25-50% infection of a plant
7	>50-75% infection of a plant
9	>75 % infection of a plant

Cercospora leaf spot

Symptoms

The disease first appears as small circular to irregular necrotic spots or lesions on older leaves. Lesions coalesce causing leaf blight and defoliation. During epidemics, lesions appear on young branches and cause their tips to dry and die back. Fluffy mycelial growth or concentric zonations on lesions are seen.



Leaf spots due to *Cercospora*

Procedure for observation

The intensity of the disease should be recorded based on the ratings given alongside of data table. The severity rating for five individual plants randomly selected in the field should be recorded. The severity rating scale of the disease is also as given below.

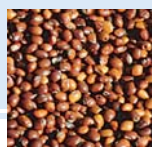
Disease rating scale for *Cercospora* leaf spot

Scale	Description
1	No symptoms
2	10% of leaflet area with spots, no chlorosis
3	10-20% of leaflet area with spots, no chlorosis
4	20-30% of leaflet area with spots, no chlorosis
5	30-40% of leaflet area with spots, no chlorosis
6	20-50% of leaflet area with spots, and mild chlorotic patches
7	20-50% of leaflet area with spots and entire leaflets severely chlorotic
8	20-50% leaflet area with spots and severe chlorosis
9	Spots covering >50% leaflet area covered with severe chlorosis, and defoliation

2.5. Additional details to be recorded for fixed fields

2.5.1. Pheromone trap catches

Pheromone traps for *Helicoverpa armigera* @ 2/ fixed field have to be installed from the start of the season. Species specific lures have to be used with the traps. Install the traps with lures in the selected field randomly each separated by a distance of 25m from the other trap. Fix the traps to the supporting pole at a height of one foot above the plant canopy. Adjust the height of the traps depending on the growth of the plants in the field in a given season. Use a cotton swab dipped in diclorvos inside the polythene bag to kill the insects getting trapped (take care that the insecticide does not come



in contact with funnel at any one time). If insecticide is not used, see to that the live moths are killed before counting/emptying. Change of lures should be made once a month. Emptying of the moths from collecting container/bag should be made after counting and recording. Ensuring the presence of traps and readiness to replace in case of breakage/missing events should be followed meticulously. Therefore after initial installation of traps with lures, surveillance team or member should carry few traps and lures during each week of surveillance for attending to missing traps immediately. Since *H. armigera* is a polyphagous pest, year round deployment of the traps and its monitoring is recommended.



Pheromone trap

Description

The adult moths have greenish grey forewings with light darker transverse bands in distal third. Hind wings are pale grey with a darker marginal band having small brown marking at base.

Male moth of *H. armigera*

Procedure for observation

During each week of surveillance the total number of moths/trap/week should be counted and recorded.

2.5.2. Plant protection sprays

During each time of visit to the fixed fields *ie.*, once in a week, the plant protection operations taken up against insects, diseases, weeds, and use of any biorationals or biopesticides including bioagents, botanicals and microbials along with their names and dosages should be collected from the farmer and entered in the table of **Page 3 of Proforma 2 (Annexure III)**.

2.5.3. Fertilizer management

During each time of visit to the fixed fields *ie.*, once in a week the details on application of green manure, farm yard manure (FYM), nutrient spray (micronutrient or hormonal) and general pattern of fertilizer use as to over use or optimal and deficit use should be recorded in the table of **Page 3 of Proforma 2 (Annexure III)**.

2.5.4. Weather events of the week

Details of weather that are prevailing during the week of surveillance in respect of the farm/village should be stated in an objective pattern of YES or NO. If any other weather pattern prevails other than those mentioned in the table, it can be written against 'Any other remarks' as a short phrase in the table of **Page 3 of Proforma 2 (Annexure III)**.

2.5.5. Grain damage at harvest

Lepidopteran borers

Description

Seeds are eaten away completely and at times partially depending on the species and larval stage of lepidopteran borers.



Seed damage due to lepidopteran borers

Bruchids

Description

Seeds have developing grubs or adults feeding on the contents. Round exit hole on a seed is typical of bruchid damage.



Bruchid damage with exit hole in seeds

Pod fly

Description

The tunneling type of feeding found on a seed is indicative of pod fly damage. Immature stages (maggots and pupae) may or may not be seen. The exit holes are seen on the pod wall.



Seed tunneling due to pod fly



Pod bugs

Description

Seeds are shriveled and have dark or discolored patches. Tiny depressions on pods and shrunken seeds are confirmatory evidence for damage due to pod bugs.



Shrunken seeds due to pod bug feeding

Procedure for observation

Fifty pigeonpea pods should be randomly collected from the field ready for harvest (not more than five pods / plant). The grains of all 50 pods should be separated and their total numbers should be noted. Damaged seeds should be separated and their total also has to be recorded. All the damaged seeds are to be examined for the cause of damage based on the symptoms described for each group of insect pests *viz.*, lepidopteran borers, bruchids, pod fly and pod bugs. The number of damaged seeds in respect of lepidopteran borers, bruchids, pod fly and pod bugs should be noted separately.

2.5.6. End season record of yield and price

One time and final recording of the yield obtained in respect of each fixed field, and the prevailing market or sale price of the pigeonpea as commodity should be collected at /after harvest and recorded in **Page 3 of Proforma 2 (Annexure III)**.

2.6. Random field survey

2.6.1. Field selection for random survey

During the survey, the team will cover about 70-80 km distance in pigeonpea dominated areas. During the survey the villages having large area under pigeonpea will be selected randomly. Around 7-8 km distance can be maintained between two villages for survey. The survey is to be conducted once in a week (Friday) by scientist along with project staff in the area/ villages not covered by scouts. Random survey should commence along with fixed field surveillance *ie.* after crop establishment, and at weekly intervals thereafter.

2.6.2. Guidelines for pest observations

All relevant details of random survey *viz.*, date of survey, GPS coordinates, village name, area of the field sampled and cultivar (if only known) should

be recorded and the pest observations are to be carried out as per the **Proforma 2 (pages 1- 2) (Annexure III)**. Eight individual data sheets (**Proforma 2**) should be used for the eight fields across eight villages during random survey. Additional details such as trap catches, plant protection sprays, fertilizer management, and weather events of the week need not be made for fields of random survey. The general information relating to **Proforma 1** also need not be collected for random fields,

3. Record of meteorological information

Daily records of weather data from the observatory of the research station or any other nearest location should be collected using the **Proforma 3 (Annexure IV)**. Their upload should be done once in a week.

4. General instructions

Depending on the agro climatic zone the species of insects/diseases vary. There could be occurrence of additional species of the same group of insect or altogether a new species so far. Therefore the hitherto unrecorded species needs to be collected and preserved for identification. Preservation of insects has to be done in 70% ethyl alcohol in screw capped glass vials. Identification and reporting can be done at your institution level directly or through crop coordinators of NICRA. Description of some of the insects and diseases of importance that are of varying significance to pigeonpea production should be maintained for reference and reporting separately.

In case of closed holidays, the surveillance should be adjusted so as to cover the fixed field and random surveys on the subsequent day, and the same flexibility applies to upload of data also. Ensure quality data collection by adhering to data sheet and guidelines.

Only presence of pests on the crop need sampling and recording of their counts/severity *etc.* columns of pests not recorded should be filled with -1. While no pest should be noted as '0'. In case of non-recording of observations in any of the fixed fields during any of the weeks, the same should be reported as 'not recorded' with reasons, in the provision that would be made in the software (Since it is research data all out efforts should be taken not to miss the data collection for any one week). Each farmer whose field has been selected can be given a diary for record keeping on the intercultural operations, plant protection sprays, fertilizer application, weather events, yield and market price of pigeonpea at harvest. By visiting the fixed fields in villages on fixed days in a week for surveillance, farmer too can be made to be an effective partner of the programme. Their contact details including postal address and phone number (landline and mobile, whichever is available) must be maintained for feedback and impact assessment in future.



Annexure I

Schedule for Surveillance

Day	Schedule of surveillance for pest scouts and data entry operator (DEO)	No. of fields
Monday	Two fixed plots (Fixed1- Unprotected) and (Fixed 2-Protected) at research station; Documentation of historical data of the center	Two
Tuesday	Two fixed fields/village at two villages (four fields) by one scout (Total of four villages and 8 fields / two scouts); DEO to enter the data collected on previous day + documentation of historical data	8 in 4 villages
Wednesday	Two fixed fields/village at two villages (four fields) by one scout (Total of four villages and 8 fields / two scouts); DEO to enter the data collected on previous day + documentation of historical data	8 in 4 villages
Thursday	Two fixed fields/village at One village (Two fields) by one scout (Total of TWO villages and 4 fields / two scouts); DEO to enter the data collected on previous day + documentation of historical data	4 in two villages
Friday	Random field survey across eight villages (@one field/village) by scientist and surveillance team; look for new/emerging pests for reporting in addition to using prescribed data sheet	8 in 8 villages
Saturday	Checking data/Upload of pest and weather data	-

(Each field of near to 0.5 to 1 acre size)

NICRA REAL TIME PEST SURVEILLANCE (PIGEONPEA)

Annexure II

(Proforma 1)

Data Sheet for General Information of Fixed fields of Surveillance

General Information for experimental and farmer fixed fields - to be filled once in the beginning of the season
Geographic Details

Agro climatic zone	State	District	Tehsil/Block	Experimental Station/ Village Name	Latitude	Longitude

Cropping system details of the region

Major cropping systems of region	Normal sowing time (from..... to.....)		New crops of the region (during last five years)
	Kharrif	Rabi	

Agromomic details of the Field

Field	Name of the farmer	Previous crop	Sole/inter crop	Name of cultivar		Growing condition (Irrigated/ rained)	Source of irrigation (Canal/well/tube well/drip)	Seed treatment (Yes/ No)			
				Variety	Short/ medium long duration			Fungicide	Insecticide	Rhizobium / PSB	Trichoderma/ Pseudomonas
Fixed 1											
Fixed 2											

Field	Date of sowing	Flat/ ridge sowing	Spacing (cm)		Soil type	Summer ploughing	Soil application (Yes/No) if yes dosage per acre			General soil health (Excellent/ good/ poor)	Crops in the adjacent fields
			Plant to plant	Row to row			FYM (Yes/ no)	Neem cake	Trichoderma		
Fixed 1											
Fixed 2											

Address of farmer 1 :

Address of farmer 2 :



Annexure III

Data Sheet for Pest Observations in Fixed and Random Fields

NICRA REAL TIME PEST SURVEILLANCE (PIGEONPEA)

Proforma 2

Page 1

State	District			Tehsil						
Experimental station				Fixed fields of farmers						
Location	Unprotected (Fixed 1)/ Protected (Fixed 2)			Village name		Fixed 1 / Fixed 2				
Field type/no.				Field no.						
Random survey	Village name	Latitude	Longitude	Altitude	Field area (ac)	Cultivar				
Date of observation			General crop health		Excellent/good/poor					
Stage of crop		Vegetative/ First flowering/ 50% flowering/ Pod setting & development/ Maturity								
Insect Pests										
Spot no. (Two plants/ spot)	Number of larvae (whole plant basis)					Maruca damage to flower buds	Any other dominant insects			
	Leaf folder	<i>H. armigera</i> larvae	Lablab pod borer	Blue butterfly	Plume moth		Other insect 1 () Specify name	Other insect 2 () Specify name	Other insect 2 () Specify name	
1.										
2.										
3.										
4.										
5.										
Pod bugs							Beneficials		Pod damage on 50 randomly collected developing pods	
Spot no. (Two plants/ spot)	<i>Clavigralla</i>	<i>Riptortus</i>	<i>Nezara</i>	Coccinellids	Spiders	<i>H.armigera</i>	Pod fly	No. of podfly immatures		
1.										
2.										
3.										
4.										
5.										
Leaf folder (<i>Grapholita</i>)	Number of larvae to be counted by opening the webbed leaves on the plant on two plants (whole plant basis)									
<i>H. armigera</i> larvae	Larvae falling on the ground should be counted after shaking the plant; Additionally number of early instar larvae present on the plants should be counted (whole plant basis) on two plants/spot									
Lab lab pod borer, blue butterfly and plume moth	For each insect, number of larvae should be counted by visual search method on whole plant basis on two plants/ spot									
<i>Maruca</i>	Number of webs of flowerbuds due to <i>Maruca</i> should be counted on whole plant basis on two plants per spot									
Other insects	Blister beetle can be counted as no. of adults on two plants (whole plant basis); ash weevils and cow bugs can be counted as no of adults on two plants per spot; Mealy bugs and scales may be graded as Grade 1: scattered presence of insects; Grade 2: 25% of plants covered; 3:50% of the plants covered; and Grade 5 : whole plant infested based on single plant per spot									
Pod bugs	Different species of pod bugs should be counted on whole plant basis by visual search on two plants/spot									
Beneficials (Coccinellids /Spiders)	Number of immature stages and adults present on one plant per spot should be counted									
Pod damage due to <i>H. armigera</i> and pod fly and pod fly immatures	During each week after setting. Fifty developing pods should be randomly collected from the fields (not more than 5 pods/plant) and examined for damage due to <i>H. armigera</i> and pod fly. The total number of pod fly immatures (maggots and pupa) should be counted together on those 50 pods and noted									

NICRA REAL TIME PEST SURVEILLANCE (PIGEONPEA)

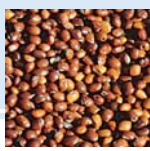
Diseases					
Spot no. (10 plants/ spot)	Number of diseased plants out of 10 plants in spot				
	<i>Fusarium</i> wilt	<i>Phytophthora</i> blight	Sterility mosaic disease (SMD)	Phyllody (MLO)	<i>Macrophomina</i> stem canker
1					
2					
3					
4					
5					

For all above diseases the number of infected plants outs of 10 plants in a spot should be counted

Disease ratings					
Spot no.	Plant 1	Plant 2	Plant 3	Plant 4	Plant 5
<i>Alternaria</i> blight severity (0-5 scale)					
1					
2					
3					
4					
5					
Rating scale for <i>Alternaria</i> blight					
0: No symptoms;		1: 1-10% of a plant infected;		2: 11-25% of a plant infected;	
3: 26-25% of a plant infected;		4: 51-75% of a plant infected;		5: 75-100% of a plant infected	

Powdery mildew severity (0-9 scale)					
1					
2					
3					
4					
5					
Rating scale for powdery mildew					
0: No symptoms;		1: Trace to <5% infection of plant		3: > 10-25% infection of a plant;	
5: >25-50% infection of a plant;		7: >50-75% infection of a plant;		9: >75% infection of a plant	

<i>Cercospora</i> severity (0-9 scale)					
1					
2					
3					
4					
5					
Rating scale for <i>Cercospora</i>					
1: No symptoms; 2: 10% of leaflet area with spots, no chlorosis; 3: 10-20% of leaflet area with spots, no chlorosis; 4: 20-30% of leaflet area with spots, no chlorosis; 5: 30-40% of leaflet area with spots, no chlorosis; 6: 20-50% of leaflet area with spots, and mild chlorotic patches; 7: 20-50% of leaflet area with spots are entire leaflets severely chlorotic; 8: 20-50% leaflet area with spots and severe chlorosis 9: Spots covering >50% leaflet area covered with sever chlorosis, and defoliation					



NICRA REAL TIME PEST SURVEILLANCE (PIGEONPEA)

Record the following for **fixed fields only**

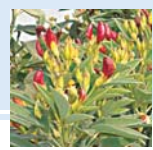
Trap No.	<i>H. armigera</i> pheromone trap catches (no. of moths/trap)
1	
2	

Plant protection sprays	Name of chemical	No. of applications
Against insects		
Against diseases		
Against weeds		
Use of biorational		

Fertiliser management	
Green manuring	Yes / No
FYM	Yes / No
Name of nutrient spray	
Type of fertiliser use	Over use/ optimal/ deficit use

Unusual weather events of the week	
Unseasonal rains	Yes / No
Hail storms	Yes / No
High intensity rains	Yes / No
Prolonged dry spells	Yes / No
Floods	Yes / No
Temperature	High/ Normal/ Low
Any other remarks	

One time observation at the end of season for all fixed fields						
Grain damage out of 50 randomly collected mature pods at harvest						
Total number of pods collected	Total number of seeds	Total number of damaged seeds	Seed damage due to			
			Lepidopteran borers	Bruchids	Pod fly	Pod bugs
50						
Damage due to individual insects should be noted based on symptoms						
Lepidopteran borers : Clear cut hole seen on the seeds with almost all contents eaten off						
Bruchids : Grub or adult of bruchid seen inside the grain/ seed						
Pod bugs : Shrunken/shriveled grains/ seeds with discoloration						
Pod fly : Smaller hole on grains/ seeds with partial feeding/ tunnelling Partially						
Yield / acre (Kg)			Market price during season (Rs. / Quintal)			



Proforma 3

Annexure IV

Data Sheet for Meteorological Observations

NICRA REAL TIME PEST SURVEILLANCE (PIGEONPEA)

METEOROLOGICAL INFORMATION (based on the nearest location / research station)

Name of Location	Latitude	Longitude	Altitude
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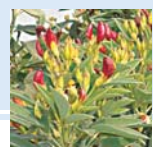
Date	Max. Temp. (°C)	Min. Temp. (°C)	RH		Rainfall (mm)	Sun shine (hrs.)	Wind velocity (km h ⁻¹)
			Morning	Evening			
	(%)	(%)					



Annexure IV

Scientific Names of Important Pigeonpea Pests and Beneficials

S.No.	Common name	Scientific name
INSECT PESTS		
1.	Leaf folder	<i>Grapholita (Cydla) critica</i> (Meyr.)
2.	Pod borer	<i>Helicoverpa armigera</i> (Hubner)
3.	Pod fly	<i>Melanagromyza obtusa</i> (Malloch)
4.	Lablab pod borer	<i>Adisura atkinsoni</i> (Moore)
5.	Blue butterfly	<i>Lampides boeticus</i> (L.)
6.	Plume moth	<i>Exelastis atomosa</i> (Walsingham)
7.	Legume (cowpea) pod borer	<i>Maruca testulalis</i> (Geyer)
8.	Blister beetle	<i>Mylabris spp.</i>
9.	Ash/Grey weevil	<i>Myllocerus undecimpustulatus</i> (Faust)
10.	Cow bugs	<i>Otinotus oneratus</i> (W.); <i>Oxyrachis tarandus</i> (F.)
11.	Mealybugs	<i>Phenacoccus solenopsis</i> Tinsley; <i>Paracoccus marginatus</i> ; <i>Coccidohystrix insolita</i>
12.	Scales	<i>Ceroplastodes cajani</i> (Maskell) <i>Icerya purchasi</i> (Maskell)
13.	Pod sucking bugs	<i>Clavigralla gibbosa</i> (Spinola); <i>C. scutellaris</i> (Westwood); <i>Nezara viridula</i> (L.); <i>Riptortus spp.</i>
14.	Bruchids	<i>Callosobruchus maculatus</i> (F.)
BENEFICIALS		
13.	Coccinelids	<i>Coccinella magnifica</i>
14.	Spiders	<i>Araneus sp.</i> ; <i>Clubiona sp.</i>
DISEASES		
1.	<i>Fusarium</i> wilt	<i>Fusarium udum</i>
2.	<i>Phytophthora</i> blight	<i>Phytophthora drechsleri</i>
3.	Sterility mosaic	Viral disease transmitted by mites
4.	Phyllody	<i>Mycoplasma Like Organism</i>
5.	<i>Macrophomina</i> stem canker	<i>Macrophomina phaseolina</i>
6.	<i>Alternaria</i> blight	<i>Alternaria alternata</i>
7.	Powdery mildew	<i>Leveillula taurica</i>
8.	<i>Cercospora</i> leaf spot	<i>Cercospora indica</i>



NOTES

A series of horizontal dotted lines for writing notes, spanning the width of the page.

