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Evaluation of pigeonpea genotypes against Sterility Mosaic Disease (SMD) caused by the mite vector, *Aceria cajani*

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Pigeonpea (*Cajanus cajan* (L.) Mills.) is one of the major pulse crops of the tropics and subtropics. It is cultivated on 5.25 million hectares with annual production of over 3 million tones contributing to about 5% of the total world production. Nearly 90% of the global pigeonpea cultivation is confined to India and Nepal, the remainder is in Africa (6%), Caribbean (2%) and other Southeast Asian countries. Nearly fifty diseases occur in mild to severe form in pigeonpea. Of these Sterility Mosaic (SM), *Fusarium* wilt and *Phytophthora* blight are economically important. SMD causes substantial yield losses to pigeonpea in India and its neighboring countries. SMD, considered to be viral in etiology is a major disease limiting the pigeonpea production in the Indian subcontinent. The SMD causal agent is spread by the mite vector, *Aceria cajani* Channabasvanna. A field experiment was conducted during the period of two years *i.e.* 2008-09 and 2009-10 at the Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. During the field experiment, 36 genotypes were screened for resistance against SMD and it was found that eighteen genotypes were free from the disease and grouped as highly resistant. Effect of different sowing dates was observed in the most susceptible variety ICP-8863, but it was found that disease development was irrespective of sowing dates. Symptom appeared after 15 days of sowing. The infection to most plants occurred in September and October in both the crop seasons i.e. 2008-2009 and 2009-2010. Mite population was also observed in these plots and it was found that mite population was highest in the month of April in 2008-2009 crop seasons and in 2009-2010 crops season maximum mite population was observed in the month of November and December. Mite population in the resistant and susceptible genotypes of pigeonpea was observed. Only a few eggs were visible in resistant varieties and heavy mite population was observed in the susceptible varieties. The effect of SMD on plant height along with their branches was also observed and can be concluded that severe mosaic affect the plant height, and branches of the pigeonpea plants. The disease severity was high in the early stage of infection causing severe mosaic disease where flower and pod formation was ceased resulting in complete crop failure.

Key words: Pigeonpea, *Aceria cajani*, SMD, sterility mosaic, PPSMV

INTRODUCTION

India is the largest producer of pulses in the world with 25% share in the global production. While chickpea is the topper among pulses occupying 39% of pulse area, pigeonpea follows with 21% area share. Pigeonpea, *Cajanus cajan* (L.) Millspaugh, is one of the major pulse crops of the tropics and subtropics. Pigeonpea also popularly known as redgram, tuar or arhar is a primary

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source of protein for millions in India. For over five decades the productivity of pigeonpea has remained low (600-700 kg per hectare) and to meet the annual domestic needs of 3.5 million tonnes, India imports about 5 lakh tonnes of redgram from Myanmar and Africa every year.(business line). Pigeonpea, the area increased slightly from 3.53 M ha to 3.73 M ha and production from 2.69 Mt in 1993–94 to 3.08 Mt in 2007–08. But area and production of pigeonpea declined in 2009–10 to 2.66 M ha and 2.47 Mt respectively. There is a positive growth in production of chickpea and pigeonpea in Andhra Pradesh, Karnataka and Maharashtra because of significant increase in area and productivity during the period. In Andhra Pradesh, the area under chickpea has increased from 71 thousand ha in 1991–93 to 619 thousand ha in 2007–09, and productivity from 621 to 1264 kg/ha.

Nene *et al.* (1981) have listed about fifty diseases occurring in mild to severe form on pigeonpea crop. Of these Sterility Mosaic (SM), *Fusarium* wilt and *Phytophthora* blight are economically important. SMD causes substantial yield losses in India and its neighboring countries. Sterility Mosaic Disease (SMD) caused by Pigeonpea Sterility Mosaic Virus (PPSMV) is widespread and economically important. Pigeonpea Sterility Mosaic Virus transmitted by the eriophyid mite, *A. cajani*, is recognized only in pigeonpea growing countries of Asia. Sterility Mosaic Disease (SMD), first described in1931 from Pusa, Bihar state of India (Mitra, 1931), is a major disease limiting the pigeonpea production in the Indian subcontinent. The disease is present in the major pigeonpea producing states of India. It is a serious problem in northeastern (Bihar and Uttar Pradesh), and southern (Tamil Nadu) states (Kannaiyan *et al.* 1984). The disease appears to be restricted to Asia and has also been reported from Bangladesh, Nepal, and Thailand (Nene *et al.* 1989), Myanmar (Su, 1931), and Sri Lanka (Newton and Peiris., 1953).

The disease is characterized by the symptoms like bushy and pale green appearance of plants followed by reduction in size, increase in number of secondary and mosaic mottling of leaves and finally partial or complete cessation of reproductive structures. Some parts of the plant may show disease symptoms and other parts may remain unaffected. The disease is sometimes referred to as the "green plague" because at flowering time, affected plants remain green with more vegetative growth and have no flower or seed pods under congenial conditions (Kumar *et al.* 2003). It spreads rapidly like a plague, leading to severe epidemics (Kulkarni *et al.* 2004). The infected plants fail to produce flower and therefore bear no pods leading to enormous losses to the farmers (Jones *et al.* 2004). Certain resistant germplasm lines have been made available to the pulse breeders in the recent past (Nene and Reddy, 1976). Mites survive for only a few hours in the absence of feeding hosts and are highly sensitive to fluctuations in relative humidity and temperature. This mite is highly host-specific with a very narrow host range, confined mainly to pigeon pea and its wild relatives, *C. scarebaeoides* and *C. cajanifolius*. Adult *A. cajani* measure 200 to 250 ì m and have a very short life cycle of about 2 weeks comprising egg (30 × 40 µm) and two nymphal stages. The mites can be seen clearly under a stereo- microscope at a magnification of 40x (Shiela *et al.* 1988).

Eggs can be detected on the growing tips of pigeonpea plants; they are milky white, oval translucent, and slightly smaller than glands of trichomes. Mites inhabit the lower surface of leaflets and are found predominantly on symptomatic leaves of PPSMV-infected plants .The presence of a large number of mites on a pigeonpea leaflet goes unnoticed mainly because their feeding causes no obvious damage to the host. Once established on PPSMV-susceptible genotypes, mites can multiply to high densities within a few weeks. Their dispersal is passive, assisted mainly by wind currents.

Sterility Mosaic has become a potential threat to the cultivation of pigeonpea in Indian subcontinent. Resistant pigeonpea genotype for specific region may be one of the methods to combat the disease and increase the yield. Information regarding the survival of mite, host, host range of mite and the pathogen and seasonal fluctuation in the mite population could be used for better understanding of the SMD.

In the present study, following aspects on SMD of pigeonpea have been elucidated: (i) evaluation of pigeon pea genotypes for resistance to SMD. (ii) effect of different dates of sowing on the symptoms appearance and incidence and population of mites and (iii) mite population on resistance and susceptible genotype of pigeonpea.

MATERIALS AND METHODS

The field experiment was conducted during the period of two years *i.e.* 2008 - 2010 in the experimental plots of Pathology block at the Institute of Agricultural Sciences, Banaras Hindu University. Experimental pigeonpea genotypes were obtained from Indian Institute of Pulses Research, Kanpur. Sowing was done of pigeonpea genotypes in 60x4 m plot size in two replications for screening. Tagging of plants was done after attaining a height of 10-15 cm. Two techniques *viz.*, leaf stapling and infector-hedge techniques were adopted for screening of different genotypes of pigeon pea against Sterility Mosaic Disease (SMD).

Leaf stapling technique

The method described by Nene *et al.* (1981) was adopted. Leaflets infected with Sterility Mosaic Disease (SMD) carrying sufficient number of mites were taken and stapled onto the young leaves of each test plants of different genotypes of pigeonpea. One diseased leaflet per primary leaf was stapled. The diseased leaves collected from the infected plant were observed under binocular microscope for the presence of eriophyid mite. The diseased leaflets were folded on the primary leaf in such a way that its lower surface came in contact with the primary leaf of the seedling. It was then stapled with a small paper stapler. In case of small diseased leave, two leaves were placed alternatively in such a way that the lower surface of the diseased leaf come in contact with both the surfaces of the leaflet of test plant. The leaves were stapled with diseased leaflet at the age of 10-15 days of seedling. The advantages of this method were that it facilitated inoculation at the primary leaf stage, and disease symptoms were rapidly expressed (Nene and Reddy, 1976). The technique is very useful in confirming resistance of the lines observed as promising under field conditions, and for disease inheritance and strain identification studies.

Infector hedge technique

The infector hedge field-inoculation technique was described by Nene *et al.* (1981). It consists of growing a hedge of a susceptible cultivar on the upwind border of a field in advance of its use as a screening nursery. Highly susceptible pigeonpea cultivar named ICP-8863 was sown 4 months earlier around the border of the field which served as infector hedge. When the seedlings of the hedge were about 10 days old, they were inoculated with the sterility mosaic pathogen, either by leaf stapling (Nene and Reddy, 1976), or by spreading diseased twigs infested with mites among the seedlings. The pathogen and mites multiplied on the hedge plants and served as source of inoculum for disease spread through wind onto test materials during the cropping season. Once a good hedge was established, it could be effective for two or three seasons. The hedge was frequently pruned to promote fresh growth and encouraged mite multiplication. This helps in identifying the combined resistance/tolerance to sterility mosaic in the genotype. Highly susceptible line ICP-8863 was sown with plant to plant distance of 4 cm, and line to line was 70 cm.

Visual screening was done considering the symptom described by Reddy *et al.* (1990). The symptoms were characterized by bushy and pale green appearance of infected plants, reduced leaf size, increase in tertiary branches from leaf number of secondary and axils, complete or partial cessation of reproductive structures were recorded. Incidence of disease was observed at pre-flowering, flowering and podding stages of the crop growth.

Symptoms *i.e.,* severe mosaic, mild mosaic and ring spots exhibited by each genotype were recorded.

Disease incidence was evaluated at the pre-flowering, flowering and pod formation stages. Thirty-five pigeonpea genotypes (including the highly susceptible ICP 8863 as the control), evaluated for resistance to Pigeonpea Sterility Mosaic Virus (PPSMV), were grouped adopting rating scale given below: HR = Highly resistant (0.00%); R = Resistant (1-10%); MR = Moderately resistant (10.1-25%); S=Susceptible (25.1-50%)

Appearance and incidence of disease

ICP-8863 the most susceptible to SMD was taken for conducting the experiment. The plots were selected near to the infector hedge and allowed the natural infection. Seed of the genotype ICP-8863 was sown in 8 rows in three plots (4.50 x 4.80 m size) with an interval of 15 days. The plants were regularly monitored to see the first symptom appearance and incidence of disease. The per cent disease incidence (PDI) was calculated adopting following formula.

$$\text{Per cent disease incidence} = \frac{\text{Number of infected plants}}{\text{Total number of plants observed}} \times 100$$

Rating scale used for defining the symptom

For easy scoring, a 7-point scale was used, this scale classified different symptom exhibited by ICP-8863 throughout the crop growth period. The scale given below is a modified form of scale given by Nene *et al.* (1981).

Mite population

Mite population was recorded at the interval of 15 days on infected plants grown at three different

Rating scale	Disease incidence	Type of symptom
1	0%	No symptom on any plant
3	0.1 -20.0%	Symptom on fewer plants
5	20.1 -50.0%	Ring spot / Mild mosaic symptom on most plants causing partial sterility
7	50.1% or more	Severe mosaic on most plants ,almost complete sterility

dates during 2008 -2010 crop season. Ten plants of the highly susceptible genotype ICP-8863 were selected randomly from each of the three plots and tagged. One younger trifoliate leaf i.e., the second or third leaf from the top from each tagged plant was collected for recording the mite population. Mite population was observed under stereobinocular microscope on the lower surface of each younger trifoliate leaf.

Mite population was recorded on leaves of resistant (IPA-8F, MAL-6, MAL-166) and susceptible (ICP-8863, IPA-234, BDN-2010) pigeon pea genotypes grown during 2009-2010 crop year. Leaves were collected from five resistant as well as the susceptible plants, to observe the effect of mite population in the development of disease. For these five plants from each of the resistant and susceptible lines were collected. Number of mites in each trifoliate leaves were recorded following the same procedure mentioned above and monthly average population was computed by adopting the method described by Janarthan *et al.* (1972).

Effect of disease on plant growth

Resistant and susceptible genotypes were selected. Their height, primary, secondary branches and also flowering for the estimation of nature of losses in both the resistant as well as in the susceptible plants were evaluated. Observations were taken when the crop reached the severe mosaic stage. t- Test was used for confirming the effect of disease on yield parameters and % reduction was calculated.

RESULTS

Evaluation of Sterility Mosaic Disease (SMD)

Incidence of Sterility Mosaic Disease in thirty-five genotypes of pigeon pea is presented in the Table 1 and the grouping of the genotypes on the basis of disease reaction is in Table 2. The genotype ICP-8863 (check) highly susceptible to sterility mosaic, showed 98-100% disease incidence, this confirmed the high pressure of disease.

Out of thirty-five genotypes of pigeonpea tested against Sterility Mosaic Disease, eighteen genotypes were completely free from disease and grouped as highly resistant, three genotypes were moderately resistant and showed 10.1-25% disease incidence while only one genotype was found to be resistant against the Sterility Mosaic Disease and showed 8.3% incidence of disease. Rest of the genotypes was susceptible to highly susceptible and showed 25.1-50% and 50.1-100% disease incidence.

Mite population and incidence of disease

Mite population was recorded at the interval of 15 days on infected plants during 2008 -2010 crop season and represented in Table 3. In 2008-2009 crop seasons, the mites were observed only in the month of February and April while in rest period of crop growth only eggs were visible on the leaf of the pigeonpea. The population of mite was 0.26

Table 1 : Incidence of sterility mosaic disease on different genotypes of pigeonpea

Genotype	Incidence of SMD (%)		Average	Disease reaction
	R1	R2		
ICP8863	100	94.73	97.36	HS
MAL-28	0.00	0.00	0.00	HR
MAL-25	0.00	0.00	0.00	HR
IPA-8F	0.00	0.00	0.00	HR
MAL-166	0.00	0.00	0.00	HR
ICP8863	100	100	100	HS
MAL-6	0.00	0.00	0.00	HR
MAL-23	0.00	0.00	0.00	HR
MAL-18	0.00	0.00	0.00	HR
MAL-13	0.00	0.00	0.00	HR
ICP-8863	100	100	100	HS
MAL-26	56.52	0.00	28.26	S
MAL13X7035XMAL-13	0.00	0.00	0.00	HR
NDA-98-1	0 .00	0.00	0.00	HR
NDA-98-6	0.00	0.00	0.00	HR
ICP-8863	100	100	100	HS
IPA-15F	66.66	0.00	33.33	S
BDN-2004-2	0.00	0.00	0.00	HR
IPA-7F	0.00	0.00	0.00	HR
BSMR-528	0.00	0.00	0.00	HR
ICP-8863	96.66	93.33	95	HS
BDN-2010	0.00	100	50	S
IPA-234	65.21	100	82.60	HS
BDN-2029	72.72	53.57	63.14	HS
IPA-16F	81.25	64.28	72.76	HS
ICP-8863	100	100	100	HS
NARAMDER AW2	0.00	0.00	0.00	HR
PHULE T-03-142	41.17	40	40.58	S
WRP-216	87.5	75	81.25	HS
NDA-03-07	0.00	21.42	10.71	MR
ICP-8863	96	100	98	HS
WRP-133	44.44	69.23	56.83	HS
JKM-213	19.23	13.63	16.43	MR
DA-11	0.00	0.00	0.00	HR
JKM-205	29.03	67.74	48.38	S
ICP-8863	100	35.29	67.64	HS
VIPULA	63.15	95	79.07	HS
NTL-30	0.00	0.00	0.00	HR
PT-03-142	15	25	20	MR

Note:

HR = Highly resistant (0.00%)
R = Resistant (1-10%)
MR = Moderately resistant (10.1-25%)
S = Susceptible (25.1-50%)
HS = Highly susceptible (50.1-100%)

per leaflet in the month of February which reached to peak (18.33 per leaflet) in April.

In 2009-2010 crop seasons, the mites were seen in the month of November and December while in rest of the month population was almost zero but few eggs were visible. The population of mites on one leaflet was recorded in the month of November and December as 2.8 and 4.6, respectively.

Effect of different sowing dates on the appearance and incidence of disease

The appearance and incidence of SMD on susceptible pigeonpea sown on different dates in 2008-2009 and 2009-2010 crop seasons is presented in Table 4. The appearance of disease was observed after 15 days of pigeonpea plants grown at respective dates, in 2008-2009 and 2009-2010 crop seasons. In 2008-2009 crop season the crop was sown on 5th August, 22nd August and 9th September. While the sowing dates in 2009-2010 were 27th July, 12th August and 24th August. The first appearance of disease was observed on 21st August, 7th September and 23rd September in 2008-2009 crop seasons while in 2009-2010 crop season the first appearance of disease was on 8th August, 25th August and 9th September, respectively.

The incidence of disease was low in the month of August showing mild mosaic symptom in both the crop season. Severe mosaic and high incidence of disease was observed in September onwards irrespective of sowing dates in both the crop season.

Mite population on resistant and susceptible genotype of pigeonpea

Population of *A. cajani* on resistant (IPA-8F, MAL-6, MAL-166) and susceptible genotype (BDN-2010, IPA -243, ICP8863) was observed during 2009-2010 crop season (Table-5). The population of mite was observed only on the susceptible genotypes of pigeonpea. The mites on susceptible genotype were seen only in the month of November and December. Susceptible genotypes registered a high number of mites (13.78, 18.96, 20.29per 3 leaves) and Sterility Mosaic Disease incidence (91-100%). The mite population was very low in resistant varieties. Only a few eggs were visible. Resistant genotypes recorded a low mean number of mites (0-0.1 per 3 leaves) and 0 % Sterility Mosaic Disease incidence.

Effect of disease on plant growth

The average heights and branches of susceptible

Table 2 : Grouping of pigeon pea genotypes on the basis of disease reaction

Disease reaction	Number of genotype	Name of genotypes
Highly resistant	18	MAL-28, MAL-25, IPA-8F, MAL-166, MAL-6, MAL-23, MAL-18, MAL-13 MAL13X7035XMAL-13, NDA-98-1, NDA-98-6, BDN-2004-2, IPA-7F BSMR-528, NARAMDER AW2, NTL30, BRG-3, DA-11
Resistant	1	TJT-501
Moderately resistant	3	NDA-03-07, JKM-213, PT-03-142
Susceptible	5	MAL-26, IPA-15F, BDN-2010 PHULE T-03-142, JKM-205
Highly Susceptible	8	IPA-234, WRP -216, WRP -133, VIPULA, BDN -2029, JKM -218, NDA-96-6, ICP-8863

and resistant genotypes of pigeonpea are presented (Table 6) and per cent reduction was obtained. The data showed that all growth characters were highly affected due to the disease. The reduction in plant height and primary/secondary branches was found to be significant which was 22.42 and 21.2, respectively.

DISCUSSION

Pigeonpea (*C. cajan*) is a important grain legume grown predominantly in the Indian subcontinent, Southern and Eastern Africa and Central America. Sterility Mosaic Disease (SMD) caused by Pigeonpea Sterility Mosaic Virus (PPSMV) is widespread and economically important. Pigeonpea Sterility Mosaic Virus transmitted by the eriophyid mite, *A. cajani*, is recognized only in pigeonpea growing countries of Asia. Different studies were made for identification of resistant genotype of pigeonpea, factors that are responsible for disease incidence, role of mite as a vector in the transmission of the disease.

Among the genotypes of pigeonpea screened, 18 genotypes were found to be highly resistant against sterility mosaic; the genotypes that show highly resistant reaction may be used by the breeder for the development of high yielding variety of pigeonpea.

Mite population, their life cycle and the incidence of disease were observed to be influenced by seasonal fluctuation of temperature; relative humidity, wind direction, speed and rain fall etc. The peak population is observed in the month of April and March where deutogynes that is the female laid eggs on new leaves that hatch in to protogynes and males. In May, protogynes that is the primary female and males die on drying leaves. In July, August when the pigeon pea crop is sown, deutogynes crawl down to crevices on wood. Deutogynes remain semi-desiccated through the winter, and they are reactivated after winter cold shock and crawl up to the opening spring bud. This life cycle is followed by all the eriophyid but they are influenced by the abiotic factors due to which yearly changes occur in the population of mite. (Jeppson *et al.* 1975). Mite population was found to be highest in the month of April, where the mean temperature was 22.44°C (maximum temperature 37.9°C and minimum temperature 26.4°C). It favoured the growth of mites. It was also found in the next year because when average temperature was 21.68°C in November (maximum temperature 30.8°C and minimum temperature 11.6°C) and 18.31°C in December (maximum temperature-25.9°C and minimum temperature 11.9°C) then mites increased their population. From this we can conclude that very high temperature is not suitable for mites, this particular range 20-30°C was found to be favourable for the growth of mite. Singh and Rathi (1997) reported a positive correlation with minimum and maximum temperature, while Reddy and Raju (1993) reported a negative correlation with temperature. The population of *A. cajani* and incidence of Sterility Mosaic Disease were found to be positively correlated and it is also reported by Lakshmikantha and Prabhuswamy (2002).

Table 3 : Effect of date of sowing on population of mite per infected leaf of pigeonpea during 2008-2009 & 2009-2010 crop seasons.

Month		No. of mite in year 2008 (Sowing date)			Average number of mite per leaflet	No. of mite in year 2009 (Sowing date)			Average number of mite per leaflet
		5th August	22nd August	9th September		27th July	10th August	24th August	
August	I	0	0	0	0	0	0	0	0
	II	0	0	0		0	0	0	
September	I	0	0	0	0	0	0	0	0
	II	0	0	0		0	0	0	
October	I	0	0	0	0	0	0	0	0
	II	0	0	0		0	0	0	
November	I	0	0	0	0	4	3	1	2.8
	II	0	0	0		4	2.4	2.4	
December	I	0	0	0	0	4.5	8	3	4.6
	II	0	0	0		4	5	3	
January	I	0	0	0	0	0	0	0	0
	II	0	0	0		0	0	0	
February	I	1	0	0	0.26	0	0	0	0
	II	0	0.6	0		0	0	0	
March	I	0	0	0	0	0	0	0	0
	II	0	0	0		0	0	0	
April	I	18	14	17	18.33	0	0	0	0
	II	14	23	14		0	0	0	

I = Reading after 15 days　II = Reading after 30 days

Table 4 : Effect of different dates of sowing on incidence of Sterility Mosaic Disease of pigeonpea during 2008-2009 and 2009-2010 crop seasons

Month	Year 2008-2009						Year 2009-2010					
	Disease incidence (%)			Type of symptom			Disease incidence (%)			Type of symptom		
	Plot1	Plot 2	Plot 3	Plot1	Plot 2	Plot 3	Plot1	Plot 2	Plot 3	Plot1	Plot 2	Plot 3
August	12.71			Fewer plants			20.60			M.M		
September	53.74	56.49	17.37	S.M	S.M	Fewer plants	58.99	81.89	6.16	S.M	S.M	Fewer plants
October	82.96	86.09	28.11	S.M	S.M	M.M	93.94	89.97	50.26	S.M	S.M	S.M
November	92.67	99.00	56.5	S.M	S.M	S.M	98.06	98.38	97.80	S.M	S.M	S.M
December	98.38	99.31	91.22	S.M	S.M	S.M	98.06	99.24	96.75	S.M	S.M	S.M
January	99.50	99.31	98.94	S.M	S.M	S.M	98.06	99.24	96.74	S.M	S.M	S.M
February	99.50	99.31	99.38	S.M	S.M	S.M	98.06	99.24	96.74	S.M	S.M	S.M
March	100	99.31	100	S.M	S.M	S.M	98.06	99.24	96.74	S.M	S.M	S.M
April	100	99.31	100	S.M	S.M	S.M	98.06	99.24	96.74	S.M	S.M	S.M
LSD (0.05)	21.05	12.25	9.83				32.83	5.03	37.50			

Note: **S.M** = Severe mosaic
M.M = Mild mosaic

FOR 2008
Plot 1 sowing date and date of appearance - 5/8/08 and 21/8/08
Plot 2 sowing date and date of appearance -22/8/08 and 7/9/08
Plot 3 sowing date and date of appearance - 9/9/08 and 23/9/08

FOR 2009
Plot 1 sowing date and date of appearance - 27/7/09 and 8/8/09
Plot 2 sow ing date and date of appearance -10/8/09 and 25/8/09
Plot 3 sowing date and date of appearance - 24/8/09 and 9/9/09

Table 5 : Mite population on resistant and susceptible genotypes of pigeonpea

Month	Resistant genotype						Susceptible genotype					
	IPA-8F		MAL-6		MAL-166		BDN-2010		IPA -243,		ICP-8863	
	Mean no. of mite / leaflet	Presence of egg	Mean no. of mite / leaflet	Presence of egg	Mean no. of mite / leaflet	Presence of egg	Mean no. of mite / leaflet	Presence of egg	Mean no. of mite / leaflet	Presence of egg	Mean no. of mite / leaflet	Presence of egg
December April	Nil	Present (Few)	Nil	Present (Few)	Nil	Present (Few)	1.79	Present more in no.	2.12	Present (more in number)	1.44	Present (more in number)

Table 6 : Effect of sterility mosaic disease on various growth parameters of susceptible and resistant genotype of pigeonpea

Characters	Name of resistant variety			Mean	Name of susceptible variety			Mean	% Reduction
	IPA-8F	MAL-6	MAL-166		ICP-8863	BDN-2010	IPA-234		
Average height (cm)	200.24	180.78	174.64	185.21	173.57	159.06	155.75	162.79	22.42
Primary and secondary branches (average)	7.92	12.94	7.37	9.4	9.29	6.78	6.43	7.4	21.2

Based on t-test (1% and 5% level of significance)

It can also be concluded that, in 2008 and in 2009 temperature and relative humidity were the main factor effecting mite population, while effect of rainfall was negligible. From this result it appears that heavy rainfall is unfavourable for the multiplication of mite. Relative humidity was strongly correlated with mite population in 2008 and showed significant correlation, a negative correlation with rainfall and relative humidity was confirmed by Singh and Rathi during the year 1997. In 2008, relative humidity in the month April was 25.1 and there was no rainfall during that period, heavy rainfall does not allow rapid multiplication of mite. In 2009-2010, relative humidity favourable was 61.3%, 64.3% and rainfall 5.8 mm, 3.6 mm. regarding the wind velocity; it was found that high wind velocity can also spread the disease. Heavy mite population was found in April where the wind velocity was high as compared to that in the month of November and December. In April it was 5.24 km/h in February 5.3, whereas in November and December it was 2.3 and 1.62 km/h, this speed does not allow the mite in their spreading to long distance. Reddy *et al.* (1990) observed the role of wind in transferring the inoculums. They reported that disease can spread up to 2 km downwind from the source of inoculums but the spread in an up-wind direction was very limited (less than 200 m) confirming that wind assist in mite dispersal.

Population of mite vector on sterility mosaic disease resistant and susceptible pigeonpea genotype was also observed .The population of mite on resistant genotype was very less, only few eggs were present. In susceptible genotype very high population of mite was obtained. Reddy and Nene (1980) found that resistant genotypes seldom support continued mite multiplication, but susceptible genotypes support increased mite numbers. Similar observations were also made by Muniyappa and Nangia (1982).

The appearance and incidence of disease was recorded on susceptible genotype ICP-8863 sown on different dates. The data revealed no any effect of sowing dates; it means the susceptible genotypes sown in any month will highly be affected by the disease. This result corroborates the findings of Shiv Om *et al.* (2008). Reddy *et al.* (1993) reported season to season variation in the incidence of sterility mosaic of pigeon pea in the farmer's field in most part of India. The infection to most plants occurs in the month of September and October. Plants were highly susceptible at early growth stage, deducing development of disease in late September and October (Reddy *et al.* 1991).

In resistant varieties flowering habit was good, and pod formation was also normal but in susceptible varieties it was found that there was complete ceasation of reproductive structure due to severe mosaic. Results obtained from the above observation clearly show reduction in all the yield parameters. Alam (1993) also reported a negative correlation between the degree of sterility and yield. Early infected crops (first 45 days) show almost complete sterility and yield loss up to 100%. Late infected plants show partial sterility (Reddy and Nene, 1981).

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