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IMPACT OF FARMSCAPING IN COWPEA ON THE DIVERSITY OF MAJOR INSECT PESTS AT POST-FLOWERING STAGE

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ABSTRACT

A field experiment to study the influence of farmscaping on the seasonal abundance of major insect pests infesting cowpea at the post-flowering stage, under plant oil treated and untreated conditions, was carried out during the year 2012 at Instructional Farm of Rajasthan College of Agriculture, Udaipur. The major insect pests at post-flowering stage of the crop were the blister beetles, *Myllabris pustulata* Thunberg and *Myllabris phalerata* (Pallas); the semi-looper, *Trichoplusia ni* Hubner; leaf miner, *Cyphosticha coerulea* Meyrick; and the spotted pod borer, *Maruca vitrata* (Fabricius). Under both untreated and treated conditions the mean density for all the major insect pests was relatively more in sole cowpea being 8.40, 3.40, 5.00 and 5.42 per cent and 7.19, 2.49, 4.17 and 4.73 per cent, respectively, than in the other farmscape treatments. The mean density of these pests was the minimum under both untreated and treated conditions in cowpea + marigold farmscape treatment and the corresponding values were 4.22, 1.48, 2.34 and 3.01 per cent and 3.28, 0.99, 1.15 and 2.15 per cent, respectively. The mean atmospheric temperature had a significant positive correlation with the population of blister beetles; whereas, the mean relative humidity and total rainfall had a significant positive correlation with the population of pod borer; while, the population of leaf miner showed significant positive correlation only with the mean relatively humidity.

Key words: Ecological engineering, diversity, *Cyphosticha coerulea, Myllabris pustulata*.

INTRODUCTION

Cowpea [*Vigna unguiculata* (Linn.) Walpers] is an important pulse crop, also known as black eyed bean or Southern pea in English, while *chola* or *choli*, *chavli, lobia* in various vernacular languages in India. Insect pests are a major biotic limiting factor in cowpea production. The pestiferous insects include aphids, flower thrips, the spotted pod borer and pod-sucking bugs. As many as 21 insect pests of different groups have been recorded damaging cowpea crop from germination to maturity (Patel *et al,* 2010). The important insect species attacking cowpea crop include aphid (*Aphis craccivora* Koch), leafhopper (*Empoasca kerri* Pruthi), thrips (*Megaleurothrips* spp.), whitefly (*Bemisia tabaci*, Genn.), leaf miner (*Acrocercops caerulea* Meyrick), spotted pod borer (*Maruca vitrata* (Fab.)), tobacco caterpillar (*Spodoptera litura* Fab.) and blue butterfly (*Euchrysops cnejus* Cnidus). The pod bugs suck sap from green pods, causing abnormal pod and seed formation, causing yield losses of 30-70 per cent (Gianessi, 2013). In Africa, insect pest infestation of cowpea can result in 90 to 100 per cent yield reduction (Oyewale and Bamaiyi, 2013). The pod borer, *M. vitrata* caused 61.43 per cent pod damage in mungbean in the unprotected control, while 5.38 to 26.05 per cent pod damage was observed under protected condition with different insecticides and bio-pesticide treatments (Sandhya Rani *et al,* 2014). The avoidable losses in yield due to insect pests have been recorded in the range of 66 to 100 per cent in cowpea (Pandey *et al* 1991). Farmscaping is a holistic approach to pest control on farms that focus on increasing biodiversity in order to maintain healthy populations of beneficial insects, birds and other wildlife as part of an ecological pest management program. The basic principles of farmscaping include increase in plant diversity, increasing the time these are available, decrease the distance the beneficial arthropods have to travel, building the multiple redundant systems (guilds- plants and beneficial), ensuring natural enemies for every life stage of the pest, anticipating pest problems and encouraging natural multiplication of the beneficial arthropods when needed to manage the pests (Sreedhar, 2012). Ecological engineering or habitat manipulation, the key element of farmscaping, has emerged as a paradigm for considering pest management approaches that are based on cultural practices informed by ecological knowledge of arthropod pest management (Gurr *et al* 2004). Farmscaping reduces the need of pesticides, lowering the cost and risks associated with indiscriminate application of pesticides. Ideal farmscape plantings provide food and shelter for beneficial organisms, suppress weeds, and grow in close proximity

to the cash crop without competing for light, water and nutrients.

MATERIALS AND METHODS

The experiment was conducted at the Instructional Farm of Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur. The trial was laid out in uniformly sized plots measuring 5m x 3m (15 sq. m) in Randomized Block Design containing six treatments [Cowpea Sole, Cowpea + Niger (2 :1), Cowpea + Marigold (2:1), Cowpea + Maize (No border 2:1), Cowpea + Maize + Marigold Border (2:1) and Cowpea + Maize + Niger Border (2:1)] with four replications of each; thus in all, there were 24 plots. The row to row distance and plant to plant spacing for cowpea were 30cm and 10cm, respectively. Sowing of the recommended variety of cowpea (RC-19) and niger (RCR 317) was done in the second week of July, 2012 as sole crop and under farmscaping combination. The seeds of early flowering Marigold variety Pusa Narangi were sown in well prepared, raised nursery beds in the last week of June, 2012. Recommended floriculture operations were followed while raising the seedlings and mature seedlings of marigold were transplanted in between two rows of cowpea at a distance of 30cm. The trial was conducted in two sets, one comprising treatment with plant oils against insect pests, termed protected condition [oils of *A. indica and P. pinnata* as aqueous spray @ 3.0%] and the other without the use of any pesticide, termed natural condition.

Population of blister beetles were recorded during the day from 10am to 12noon from 10 plants per replication, selected at random and tagged, observing each plant for 2 minutes. The population of semilooper and leaf miner were also recorded from the same 10 plants per replication during early hours of the day from 6 to 8am. The population of pod borer was recorded at each picking after sorting the damaged pods from healthy pods, sampled from the same 10 plants in each replication and expressed in terms of percent damage. All the observations were taken at weekly intervals beginning from the date of first infestation observed. The mean density of the pest population was computed in relation to the total numbers of plants sampled as:

$$\text{Mean density} = \sum \frac{Xi}{N} \times 100$$

Where,

Xi = Number of insects in i^{th} sample

N = Total numbers of plants sampled.

The abiotic factors *viz.,* temperature, relative humidity and rainfall were recorded during the crop season and their simple correlation with the population of insect pests was calculated by the Karl Pearson formula of correlation coefficient:

$$r_{xy} = \frac{\sum XY - \frac{\sum X \sum Y}{n}}{\sqrt{\left[\sum X^2 - \frac{(\sum X)^2}{n}\right]\left[\sum Y^2 - \frac{(\sum Y)^2}{n}\right]}}$$

Where,

r_{xy} = Simple correlation coefficient.

X = Variable i.e. abiotic component

(Average temperature, relative humidity and total rainfall)

Y = Variable i.e. mean number of insect pests per plant.

n = Number of observations.

The correlation coefficient (r) values were subjected to the test of significance using t- test: The calculated t-value obtained was compared with tabulated t-value at 5% level of significance.

$$t = \frac{r}{\sqrt{1 - r^2}} \times \sqrt{n\text{-}2} \sim t_{n-2} \text{ d.f.}$$

RESULTS AND DISCUSSION

The seasonal abundance of major insect pests of cowpea in the different farmscapings under untreated conditions showed that the mean density for all the major insect pests was relatively more in sole cowpea than in the other farmscape treatments. The maximum per cent mean density values for the respective major insect pests observed were as follows: blister beetles (8.40), semilooper (3.40), leaf miner (5.00) and pod borer (5.42). Farmscaping cowpea with marigold resulted in the minimum per cent mean density values for the respective insect pests that were 4.22 (blister beetle), 1.48 (semilooper), 2.34 (leaf miner) and 3.01 (pod borer) [Tables 1(a) – 4(a)]. Similarly, under treated conditions, the maximum per cent mean density for the respective major insect pests observed were as follows: blister beetles (7.19), semilooper (2.49), leaf miner (4.17) and pod borer (4.73) in sole cowpea; whereas, farmscaping cowpea with marigold resulted in the lowest per cent mean density values for the respective insect pests being 3.28, 0.99, 1.15 and 2.15 per cent [Tables 1(b) - 4(b)]. Under both untreated and treated conditions the mean atmospheric temperature had a significant positive correlation with the population of blister beetles and the coefficient of correlation values (r) ranged from 0.86 to 0.94 for untreated and 0.84 to 0.93 for plant oil treated cowpea. The mean relative humidity and total rainfall had a significant positive correlation with the population of pod borer; while, the population of leaf miner showed significant positive correlation with the

Table 1 (a). Seasonal population trend of blister beetle on untreated cowpea as sole and with different farmscapings (FS) during *kharif*, 2012

Dates of observation *kharif*, 2012	Mean Atm. Temp. (C)	Mean RH. (%)	Total Rainfall (mm)	Mean / plant					
				Sole cowpea	FS-1	FS-2	FS-3	FS-4	FS-5
05 –Sept	25.63	77.28	08.11	3.42	2.52	3.05	1.85	2.20	2.72
12 –Sept	25.00	89.21	17.97	3.30	2.40	2.90	1.70	2.00	2.60
19 –Sept	25.74	80.14	12.25	3.62	2.70	3.22	2.05	2.42	2.90
26 –Sept	24.10	69.85	00.00	3.20	2.35	2.80	1.40	1.80	2.65
02 –Oct	23.48	59.28	04.85	3.12	2.10	2.70	1.22	1.52	2.40
09 –Oct	26.57	52.56	00.00	3.50	2.60	3.12	1.90	2.30	2.82
Seasonal Mean	25.31	72.65	72.29	3.36	2.45	2.97	1.69	2.04	2.68
Mean Density (%)				8.40	6.11	7.41	4.22	5.10	6.70
Coefficient of correlation (r) for population and Atm. Temp.				0.89*	0.90*	0.92*	0.93*	0.94*	0.86*
Coefficient of correlation (r) for population and RH				0.16	0.23	0.16	0.30	0.23	0.13
Coefficient of correlation (r) for population and Total Rainfall				0.21	0.17	0.19	0.33	0.23	0.02

Legend: FS-1= Cowpea + Niger; FS-2= Cowpea + Maize; FS-3= Cowpea + Marigold; FS-4= Cowpea + Maize + Bordered with Marigold; FS-5= Cowpea + Maize + Bordered with Niger; * Value of 't'- statistically significant at 5%

Table 2 (a). Seasonal population trend of semi-looper on untreated cowpea as sole and with different farmscapings (FS) during *kharif*, 2012

Dates of observation *kharif*, 2012	Mean Atm. Temp. (C)	Mean RH. (%)	Total Rainfall (mm)	Mean / plant					
				Sole cowpea	FS-1	FS-2	FS-3	FS-4	FS-5
05 –Sept	25.63	77.28	08.11	3.42	2.52	3.05	1.85	2.20	2.72
12 –Sept	25.00	89.21	17.97	1.05	0.62	0.82	0.37	0.55	0.70
19 –Sept	25.74	80.14	12.25	1.37	0.95	1.20	0.55	0.70	1.15
26 –Sept	24.10	69.85	00.00	1.72	1.35	1.50	1.00	1.25	1.42
02 –Oct	23.48	59.28	04.85	1.30	0.67	1.15	0.45	0.60	1.00
09 –Oct	26.57	52.56	00.00	0.00	0.00	0.00	0.00	0.00	0.00
Seasonal Mean	25.31	72.65	72.29	1.36	0.90	1.17	0.59	0.78	1.07
Mean Density (%)				3.40	2.24	2.92	1.48	1.94	2.67
Coefficient of correlation (r) for population and Atm. Temp.				-0.27	-0.02	-0.30	-0.22	-0.23	-0.17
Coefficient of correlation (r) for population and RH				-0.49	-0.19	-0.57	-0.30	-0.26	-0.15
Coefficient of correlation (r) for population and Total Rainfall				-0.87	-0.68	-0.89	-0.78	-0.76	-0.83

Legend: FS-1= Cowpea + Niger; FS-2= Cowpea + Maize; FS-3= Cowpea + Marigold; FS-4= Cowpea + Maize + Bordered with Marigold; FS-5= Cowpea + Maize + Bordered with Niger;

Table 3 (a). Seasonal population trend of leaf miner on untreated cowpea as sole and with different farmscapings (FS) during *kharif*, 2012

Dates of observation *kharif*, 2012	Mean Atm. Temp. (C)	Mean RH. (%)	Total Rainfall (mm)	Mean / plant					
				Sole cowpea	FS-1	FS-2	FS-3	FS-4	FS-5
19 -Sept	25.74	80.14	12.25	2.70	1.75	2.45	1.30	1.57	2.10
26 -Sept	24.10	69.85	00.00	2.40	1.45	2.12	1.10	1.20	1.77
02 –Oct	23.48	59.28	04.85	1.60	1.35	1.47	0.90	1.10	1.42
09 –Oct	26.57	52.56	00.00	1.30	0.90	1.10	0.45	0.55	1.00
Seasonal Mean	25.31	72.65	72.29	2.00	1.36	1.79	0.94	1.11	1.57
Mean Density (%)				5.00	3.41	4.46	2.34	2.76	3.93
Coefficient of correlation (r) for population and Atm. Temp.				-0.12	-0.33	-0.15	-0.38	-0.33	-0.22
Coefficient of correlation (r) for population and RH				0.98*	0.95*	0.99*	0.95*	0.94	0.99*
Coefficient of correlation (r) for population and Total Rainfall				0.58	0.77	0.62	0.67	0.77	0.70

Legend: FS-1= Cowpea + Niger; FS-2= Cowpea + Maize; FS-3= Cowpea + Marigold; FS-4= Cowpea + Maize + Bordered with Marigold; FS-5= Cowpea + Maize + Bordered with Niger; * Value of 't'- statistically significant at 5%

Table 4 (a). Seasonal population trend of pod borer on untreated cowpea as sole and with different farmscapings (FS) during *kharif*, 2012

Dates of observation *kharif*, 2012	Mean Atm. Temp. (C)	Mean RH. (%)	Total Rainfall (mm)	Mean / plant					
				Sole cowpea	FS-1	FS-2	FS-3	FS-4	FS-5
12 -Sept	25.00	89.21	17.97	3.30	2.65	2.85	1.85	2.40	2.75
19 -Sept	25.74	80.14	12.25	2.60	2.22	2.40	1.62	1.85	2.27
26 -Sept	24.10	69.85	00.00	1.50	1.20	1.30	0.75	0.92	1.25
02 -Oct	23.48	59.28	04.85	1.27	1.00	1.20	0.60	0.85	1.12
09 -Oct	26.57	52.56	00.00	0.00	0.00	0.00	0.00	0.00	0.00
Seasonal Mean	25.31	72.65	72.29	2.17	1.77	1.94	1.21	1.51	1.85
Mean Density (%)				5.42	4.42	4.84	3.01	3.76	4.62
Coefficient of correlation (r) for population and Atm. Temp.				0.80	0.85	0.84	0.88	0.79	0.83
Coefficient of correlation (r) for population and RH				0.97*	0.97*	0.96*	0.96*	0.95*	0.96*
Coefficient of correlation (r) for population and Total Rainfall				0.94	0.93	0.95*	0.93	0.96*	0.95*

Legend: FS-1= Cowpea + Niger; FS-2= Cowpea + Maize; FS-3= Cowpea + Marigold; FS-4= Cowpea + Maize + Bordered with Marigold; FS-5= Cowpea + Maize + Bordered with Niger; * Value of 't'- statistically significant at 5%

Table 1 (b). Seasonal population trend of blister beetle on plant oil treated cowpea as sole and with different farmscapings (FS) during *kharif*, 2012

Dates of observation *kharif*, 2012	Mean Atm. Temp. (C)	Mean RH. (%)	Total Rainfall (mm)	Mean / plant					
				Sole cowpea	FS-1	FS-2	FS-3	FS-4	FS-5
05 - Sept	25.63	77.28	08.11	2.95	2.15	2.62	1.45	1.70	2.30
12 - Sept	25.00	89.21	17.97	2.80	1.92	2.50	1.30	1.60	2.20
19 - Sept	25.74	80.14	12.25	3.15	2.30	2.80	1.62	1.90	2.55
26 - Sept	24.10	69.85	00.00	2.80	1.90	2.55	1.10	1.52	2.20
02 – Oct	23.48	59.28	04.85	2.55	1.75	2.25	0.90	1.30	1.82
09 - Oct	26.57	52.56	00.00	3.00	2.20	2.70	1.50	1.75	2.42
Seasonal Mean	25.31	72.65	72.29	2.88	2.04	2.57	1.31	1.63	2.25
Mean Density (%)				7.19	5.09	6.43	3.28	4.07	5.62
Coefficient of correlation (r) for population and Atm. Temp.				0.86*	0.90*	0.84*	0.93*	0.88*	0.86*
Coefficient of correlation (r) for population and RH				0.23	0.10	0.19	0.28	0.29	0.24
Coefficient of correlation (r) for population and Total Rainfall				0.14	0.09	0.06	0.28	0.25	0.13

Legend: FS-1= Cowpea + Niger; FS-2= Cowpea + Maize; FS-3= Cowpea + Marigold; FS-4= Cowpea + Maize + Bordered with Marigold; FS-5= Cowpea + Maize + Bordered with Niger; * Value of 't'- statistically significant at 5%

Table 2 (b). Seasonal population trend of semilooper on plant oil treated cowpea as sole and with different farmscapings (FS) during *kharif*, 2012

Dates of observation *kharif*, 2012	Mean Atm. Temp. (C)	Mean RH. (%)	Total Rainfall (mm)	Mean / plant					
				Sole cowpea	FS-1	FS-2	FS-3	FS-4	FS-5
12 - Sept	25.00	89.21	17.97	0.72	0.30	0.57	0.20	0.25	0.50
19 - Sept	25.74	80.14	12.25	1.07	0.75	0.90	0.45	0.55	0.82
26 - Sept	24.10	69.85	00.00	1.35	0.97	1.17	0.67	0.80	1.07
02 – Oct	23.48	59.28	04.85	0.85	0.50	0.67	0.27	0.35	0.60
09 - Oct	26.57	52.56	00.00	0.00	0.00	0.00	0.00	0.00	0.00
Seasonal Mean	25.31	72.65	72.29	1.00	0.63	0.83	0.40	0.49	0.75
Mean Density (%)				2.49	1.58	2.07	0.99	1.22	1.87
Coefficient of correlation (r) for population and Atm. Temp.				-0.05	-0.02	-0.02	-0.02	-0.04	-0.02
Coefficient of correlation (r) for population and RH				-0.29	-0.33	-0.25	-0.24	-0.27	-0.10
Coefficient of correlation (r) for population and Total Rainfall				-0.73	-0.73	-0.71	-0.70	-0.72	-0.71

Legend: FS-1= Cowpea + Niger; FS-2= Cowpea + Maize; FS-3= Cowpea + Marigold; FS-4= Cowpea + Maize + Bordered with Marigold; FS-5= Cowpea + Maize + Bordered with Niger

Table 3 (b). Seasonal population trend of leaf miner on plant oil treated cowpea as sole and with different farmscapings (FS) during *kharif*, 2012

Dates of observation *kharif*, 2012	Mean Atm. Temp. (C)	Mean RH. (%)	Total Rainfall (mm)	Mean / plant					
				Sole cowpea	FS-1	FS-2	FS-3	FS-4	FS-5
19 - Sept	25.74	80.14	12.25	2.30	1.32	2.15	0.72	1.12	1.75
26 - Sept	24.10	69.85	00.00	1.90	1.10	1.72	0.52	0.85	1.42
02 – Oct	23.48	59.28	04.85	1.37	0.80	1.25	0.40	0.62	1.05
09 - Oct	26.57	52.56	00.00	1.10	0.55	0.80	0.20	0.35	0.70
Seasonal Mean	25.31	72.65	72.29	1.67	0.94	1.48	0.46	0.74	1.23
Mean Density (%)				4.17	2.36	3.70	1.15	1.84	3.08
Coefficient of correlation (r) for population and Atm. Temp.				-0.08	-0.18	-0.18	-0.19	-0.18	-0.18
Coefficient of correlation (r) for population and RH				1.00*	0.99*	0.99*	0.99*	0.99*	0.99*
Coefficient of correlation (r) for population and Total Rainfall				0.68	0.67	0.70	0.77	0.73	0.70

Legend: FS-1= Cowpea + Niger; FS-2= Cowpea + Maize; FS-3= Cowpea + Marigold; FS-4= Cowpea + Maize + Bordered with Marigold; FS-5= Cowpea + Maize + Bordered with Niger; * Value of 't'- statistically significant at 5%

Table 4 (b). Seasonal population trend for pod borer on plant oil treated cowpea as sole and with different farmscapings (FS) during *kharif*, 2012

Dates of observation *kharif*, 2012	Mean Atm. Temp. (C)	Mean RH. (%)	Total Rainfall (mm)	Mean / plant					
				Sole cowpea	FS-1	FS-2	FS-3	FS-4	FS-5
12 - Sept	25.00	89.21	17.97	2.90	1.92	2.30	1.45	1.62	2.15
19 - Sept	25.74	80.14	12.25	2.35	1.65	1.82	1.22	1.42	1.72
26 - Sept	24.10	69.85	00.00	1.22	0.87	1.02	0.45	0.72	0.75
02 – Oct	23.48	59.28	04.85	1.10	0.77	0.90	0.32	0.60	0.70
09 - Oct	26.57	52.56	00.00	0.00	0.00	0.00	0.00	0.00	0.00
Seasonal Mean	25.31	72.65	72.29	1.89	1.30	1.51	0.86	1.09	1.33
Mean Density (%)				4.73	3.26	3.78	2.15	2.73	3.33
Coefficient of correlation (r) for population and Atm. Temp.				0.82	0.86	0.80	0.87	0.88	0.82
Coefficient of correlation (r) for population and RH				0.96*	0.96*	0.96*	0.96*	0.96*	0.95*
Coefficient of correlation (r) for population and Total Rainfall				0.95*	0.94	0.95*	0.93	0.93	0.96*

Legend: FS-1= Cowpea + Niger; FS-2= Cowpea + Maize; FS-3= Cowpea + Marigold; FS-4= Cowpea + Maize + Bordered with Marigold; FS-5= Cowpea + Maize + Bordered with Niger; * Value of 't'- statistically significant at 5%

mean relative humidity [Tables 1 (a) - 4 (a) to 1(b) - 4(b)].

A number of workers have reported that enhanced plant diversity reduced the abundance of pestiferous insects in different crops. Two experiments were conducted in Kenya to establish the relationship between insect suppression by intercropping and grain yield in sorghum and cowpea. Treatments consisted of monocrops and intercrops of sorghum and cowpea, and an additional pair of monocultures and mixtures protected by insecticides. Intercropping reduced the numbers of *Chilo partellus* in sorghum and *Megalurothrips sjostedti* in cowpea (Ampong, 1994). Soundararajan and Chitra (2012) observed that the sucking pests, *B. tabaci* and *E. kerri* population was low in the intercropped blackgram when compared to sole crop. Legume pod borer and other pod borer damage were low in the sorghum intercropped blackgram. The non-leguminous cereals intercropped blackgram plants had lower pest incidence as well as higher coccinellid population. Lower pest pressure on cowpea crop, higher abundance of predators and higher cowpea yields were observed to be associated with cowpea/greengram cropping systems; therefore, cowpea/greengram should be promoted among other biological control conservation strategies, aiming at enhancing natural enemies in cowpea systems, through habitat manipulation (Munyulia *et al*., 2006). Hassan (2009) reported that population of aphids (*Aphis craccivora* Koch.) and thrips (*Megalarothrips sjostedi* Trybom) were significantly (P>0.05) lower in cowpea + sorghum intercrop in 2006 and 2007 cropping season than sole cowpea crop. Similarly in 2007 cropping season, population of pod borer (*Maruca vitrata*) was significantly (P>0.05) lower in cowpea + sorghum intercrop than sole crop of cowpea.

With regard to the impact of abiotic factors of the environment on the insect pests; earlier, Yadav and Singh (2013) reported that population of blister beetle and pod bug showed mild positive correlation with the maximum, minimum and mean temperatures on greengram. Jain *et al* (2013) observed that the population of blister beetle on greengram showed positive correlation with the mean atmospheric temperature. Srilaximi and Ravindra (2010) recorded that light rainfall in the range of 237.8 mm to 250.2 mm (2009), 141.7 mm to 219 mm (2010), and a maximum temperature of 34 ^{0}C (2009), 34.5 ^{0}C (2010), created a conducive environment supporting the build-up of blister beetle (*M. pustulata)* and its multiplication to a high level on pigeonpea crop. Kumar and Kumar (2015) observed that the maximum relative humidity had a highly significant positive correlation with population of pod borer larvae in flower bud (r=0.8778) and pod (r=0.9450), indicating the increase in larval population with an increase in maximum relative humidity. Oghiakhe *et al* (1991) obtained a positive correlation for percentage pod damage and larval infestation of *M. testulalis* to cowpea flowers with relative humidity.

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