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CONTENTS

A COMPARATIVE STUDY OF CLIMATE AND PEST OUTBREAK IN THE SUB-HUMID PART OF NIGERIA: A CASE STUDY OF KABBA, KOGI STATE, NIGERIA

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Abstract

The menace of pest outbreak has always been a major constraint to agricultural productivity, especially in developing countries such as Nigeria. Various efforts have been geared towards reducing the havoc by pests on crops, such, that no particular method can be judged to be exclusively the best. The present study is an attempt aimed at incorporating the modern and the indigenous techniques of pest control and the management of pest outbreak in Nigeria. Information on both Data were sourced using both primary & secondary means. The frequency of grass hopper occurrence and climate variables, such as rainfall amount and frequency, number of rainday, temperatures (soil and air), relative humidity and sunshine duration, were collected for the period of 14 years (1976-1989). Also, questionnaire was designed to examine farmers' perception on the impact of climate on crop pest outbreak. Simple frequency, percentages and means were calculated from the data collected while chi-square technique of analysis was used to determine the randomness of response and to relate indigenous farmers' perception to the scientific conclusion as observed through the result of analysis of meteorological data collected. The result of the analysis revealed the existence of an overlap between indigenous knowledge and the modern scientific approach. For instance, observed years are subsumed within the range of the years perceived as severe. However, farmers could not vividly recollect the years of mild outbreak. Again, both modern scientific and indigenous approaches acknowledge drought as the main catalyst to grass hopper menace in Kabba. A combination of their knowledge with documented evidence, based on research, would provide optimal management of pest outbreak and agricultural planning in the area. An integration of the approaches is therefore being suggested in this paper.

Introduction

Most Nigerian farmers are faced with problems of drought, crop diseases and pest outbreak. According to Fagone (1983) and Atteh (1984), climate and pest would appear the most relevant in determining the quality and quantity of farm output in Kabba and its environs. The farmers' perception and understanding of these problems, therefore, become very crucial in any effort aimed at increasing food production and sustainable development of our environment. Indeed, farmers' perception of their climatic environment and their response to changes have been found sufficiently adequate to cope with the vagaries associated with the cultivation of local food products. Lado (1988), David (1984), Atteh (1984) Fagoone (1983) in Fagoone (1983) observed that the climatic factors that are crucial for crop growth and development are incidentally the same factors that favour the outbreak of pests.

However, in the U.K, empirical method was adopted to study the relationship between climate and pest outbreak (Morrison and Spence 1989). From their study, weather conditions in the winter and spring were observed to be important in determining the magnitude of pest and pathogen infestation of crops. Better still, Ricci et al (1979) recognised temperature to be the major factor responsible for the spread of soil fungus named Penicillum Oxallicium (cush-cush yam plague) in the tropics.

Most of these researchers have either studied pest and climate or used empirical deterministic approach in their research work. The benefit of integrating both traditional and scientific approaches in understanding farmers climatic environment cannot be over emphasised. The present paper is therefore aimed at examining the relationship between climate and pest outbreak in Nigeria, using both modern scientific and traditional approaches. Specifically, we shall examine the climatic pattern of Kabba area; the outbreak of grasshopper of various severity and farmers' perception of the relationship between weather and grasshopper outbreak. Based on the results of this study, appropriate remedial measures to curtail the menace of zonocerus variegatus (grasshopper) will be suggested.

The Study Area

Kabba, the study area, is in Kogi State of Nigeria. It is located on latitude 07^0, 50^{0}N and longitude 06^0 04'E (Fig. 1). It is characterised by a tropical dry and wet climate, the area shows uniformly high air and soil temperatures throughout the year (Fig. 2). Kabba exhibits a marked seasonal rainfall variation. Rainy season starts in April and lasts till October. During this period, rain of high intensity falls and the frequency is high. These climatic conditions favour maximum egg laying and subsequent development of zonocerus variegatus (Olanrewaju, 1995). Much of the land is covered by secondary forest, otherwise known as derived savanna, which serves as a good breeding ground for zonocerus grasshopper as the trees provide shade which protect zonocerus variegatus from direct impact of insolation (Aina, 1984).

Materials and Methods

The primary source of data for this study was a questionnaire designed to collect data on the socio-economic status of farmers, their cultural practice and knowledge of climatic influence on food production. The Kwara State Agricultural Development Projects (ADP) provided information on the frequency of occurrence of the outbreak of zonocerus grasshopper in the area. The meteorological centre of the ABU Zaria located at the College of Agricultural Farm Centre Kabba was the source of climatic data: The amount and frequency of rainfall, the temperature, sunshine duration, relative humidity and soil temperature were all collected from this centre for the period 1976-1989. Simple method of calculating frequency, percentages and means were used for the analyses . In addition, the chi-square technique of analysis was used to determine randomness of responses and to relate farmers perception to the meteorological data collected.

Results and Discussion

The impact of climate on the outbreak of zonocerus

grasshopper in Kabba environ is considered and the results are discussed below. Also the farmers' views on the role of climate in the outbreak of zonocerus were examined.

Table 1 shows the frequency of zonocerus outbreak in Kabba, indicating severe and mild infestations. Each of the years described 'severe' witnessed outbreak: twice the first outbreak extends from October and persists until December while the second outbreak spans between January and March of the following year. However for mild episode, adult grasshoppers appear only once in January and prevail till March of the same year.

TABLE 1: FREQUENCY OF ZONOCERUS OUTBREAK IN KABBA 1976-1981

Year	Magnitude of infestation	Frequency
1976	S	2
1977	M	1
1978	S	2
1979	M	1
1980	S	2
1981	M	1
1982	S	2
1983	M	1
1984	M	1
1985	M	1
1986	M	1
1987	M	1
1988	M	1
1989	M	1
Total	S = 4 X 2 = 8 M = 1 X 1 = 10	18

Source: Kwara Pest 4/11 & 111/Grasshopper control. Key M = mild, S = severe

Table 2.1 a and b reflect the monthly pattern of rainfall amount, frequency, number of raindays, wettest months and relative humidity during both severe and mild episodes. It is apparent from this table that variation exists in rainfall parameters during the two episodes. Higher of amount monthly rainfall frequency and number of raindays characterize the year described as mild than period of severe grasshopper infestation.

The timing of rainfall is as important as the amount in determining zonocerous outbreak. For instance, the years described as mild (1977,1981,1983,1987) witnessed early onset of rainfall than years described as severe. During 1977, the month of January recorded 45.7mm and thereafter, monthly rainfall amount ranged between 94.0mm in March and 351.5mm in August, making this month the wettest month. The trend of rainfall during 1981 and 1987 followed similar pattern but with the months of August and July being the wettest months respectively. However, slight variation is observed during 1983. During this year, there was a delay in rainfall onset but this was compensated

for by late rainfall ceasation. Rainfall did not start until March (Table 1a) but lasted through December.

The years described as severe (1976, 1978, 1980 and 1982) experienced late onset of rainfall. The worst of these were 1976 and 1982 when rainfall of significant amount did not fall until April. It appears such dry period favours the sustenance of adult grasshopper, thus exposing cassava, citrus, vegetables (maintained through irrigation) to grasshopper ravaging. Generally, the monthly distribution of rainfall is lower during the severe years of pest infestation (table 2.1b).

The frequency of rainfall is higher during the 'mild' than 'severe' years. For instance, number of raindays during the mild years are 110, 110, 96, and 104 for 1977, 1981, 1983 and 1987 described as mild years. On the other hand, severe years (1976,1978, 1980 and 1982) recorded 78, 69, 89 and 87 raindays (table 1a and b). Rainday has been defined by Olaniran and Babatolu (1987) as days with rainfall exceeding 1mm.

Mean monthly relative humidity is slightly lower during the years described as mild than years that witnessed severe outbreak. For 'severe' period, the lowest relative humidity of 40.7% was recorded during January 1982 while the highest of 98.3% was observed in September 1980. The range of relative humidity during the mild episode was between 42.1% as recorded in January, 1981 and 84.5% was recorded in September 1977.

Tables 2.2a and b reflect the pattern of monthly temperatures (soil and air) and sunshine duration for mild and severe years. Temperatures were high throughout the two episodes. For severe year table 2.2 (a) the lowest maximum temperature of 22.2^0c was recorded in February 1976 while the highest of 35.1^0c was recorded in March 1982. Similarly the lowest minimum temperature of 15.5^0c was recorded in February 1976 while the highest of 23.9^0c was recorded both in March 1978 and 1980. This trend persisted throughout the mild years and soil temperature was equally high throughout. It ranged between 20.8^0c in May 1987 and 30.4^0c in Feb 1977; for mild years and between 10.6^0c in December 1976 and 33.1^0c in March 1982. soil temperature data were collected at 10cm depth because variegatus grasshoppers do not dig beyond this depth for egg laying and hatching (Millingstone, 1983).

Sunshine duration varies slightly during the two episodes. This agrees with Hopkin (1979) that tropical area shows seasonal variation in sunshine duration. Sunshine of longer duration was observed during the mild year (table 2.2b). In 1977 for instance, the range was 4.7 and 6.7 hrs, 1981, 4.3-6.4hrs, 1983 5.1-7.4 hrs and 1987 5.1-7.1 hrs. On the other hand, for severe years, 1976 has the range of 4.4-6.1 hrs, 1978 3.8-6.5hrs, 1980 4.1-6.3 hrs and 1982 5.0-6.2 hrs. Based on this, one may conclude that long sunshine duration inhibit zonocerus activities. This also agrees with the findings of Youdeowei and Service (1983) that zonocerus are less active when exposed to long duration of heat, since heat is a resultant effect of sunshine. Focusing climate on the two episodes revealed rainfall amount, frequency of fall and sunshine duration as critical parameters in determining temporal variation of grasshopper severity.

Climate and the Life Cycle of Zonocerus Grasshopper

The three phases in zonocerus grasshopper life cycle are egg, larva and adult stages. Egg laying process occurs between the month of April through June at Kabba while the period that witnesses hatching of grasshopper eggs include the months of July, August and September. The duration identified as adult stage differs according to different episodes. For severe years, outbreak of adult grasshoppers is witnessed twice. The first outbreak is observed between October and December while the second occurs between January and March of the following year. However, for mild episode, adult grasshoppers appear only in Jan. and lasts till March.

Table 3: Mean Monthly Climatic Conditions During the Life Stages of Grasshopper in Kabba

Mean climatic conditions	Egg laying stage (April – June)		Larva stage (July – September)		Adult stage Oct – Dec Jan – Marc	Jan – Mar
	Severe	Mild	Severe	Mild	Severe	Mild
Rainfall (mm)	146.06	82.46	204.97	242.03	26.1	46.94
Rainfall frequency	9.75	7.51	13.42	15.0	3.00	4.08
Relative humidity (%)	78.71	62.58	84.85	73.98	74.00	62.11
Air max temp (^{0}c)	30.42	31.27	28.80	28.41	33.80	31.16
Air mini temp (^{0}c)	21.06	20.55	20.27	20.33	23.90	19.40
Soil temp (^{0}c)	28.40	27.70	23.62	24.09	29.40	24.64
Sunshine duration (hr)	5.50	6.10	5.41	5.26	5.00	5.40

Source: Author's field, work 1995

Climatic situations experienced during different ontogenetic stages vary. During the egg laying exercise, nearly all-climatic variables are high. For instance, rainfall and relative humidity were fairly high for the two episodes. Rainfall mean of 82.46mm was recorded for mild year but a considerable rise of 146.06mm was observed for severe years. Relative humidity for mild period was 62.58% and 78.1% for severe years. The maximum and minimum temperatures were 30.42^{0}c and 21.06^{0}c for severe year while mild year recorded 31.27^{0}c and 20.55^{0}c respectively. Rainfall frequency (the occurrence of rainfall) stood at 9.75mm for severe year and dropped to a value of 7.5mm for mild year. Soil temperatures were high for the two episodes (28.39^{0}c for severe and 27.7^{0}c for mild years).

During the larva stage, rainfall amount was high generally, but it was higher during the mild years with 242.03mm compared with 204.97mm recorded during severe years. Also, severe years enjoyed lower rainfall frequency of 13.42mm while mild years experienced higher value of 15.4mm. The air temperature was high for the two episodes, but was lower than the situation experienced during egg laying. For mild and severe years the temperature was 28.41^{0}c and 28.8^{0}c (for maximum temperatures) while it was 20.33^{0}c and 20.27^{0}c for minimum temperature respectively. Generally speaking, it would appear as if the climatic situations that encourages egg laying inhibits larva development.

Very low rainfall amount, frequency and low relative humidity for the two episodes characterized the adult stage of grasshopper. Nevertheless, there existed some variations. For instance the periods of severe infestation recorded lower rainfall amount of 26.1mm while mild year recorded higher value of 46.94mm. Higher rainfall frequency of 4.08mm was recorded during mild years compared with 3.0mm recorded for severe year. The relative humidity did not follow the rainfall pattern, thus, while the value for mild year was 62.11%, it rose to 74.0% during severe years. Although maximum air temperatures were generally high, the highest value of 33.8^{0}c was recorded during the severe episode but it dropped to 31.15^{0}c during mild years. Considering the above observations, each phase of the life cycle has its own characteristic weather pattern. For instance, while high rainfall and high temperature enhance egg lying, low rainfall encourages adult infestation.

Inconclusion different weather pattern is associated with different degrees of grasshopper outbreaks (mild & severe) and grasshopper ontogenetic stages of egg, larval and adult.

Perception of Climatic Influence on Grasshopper

Farming is the major occupation and the common farm implements used are hoes and cutlasses. Major farming practices include shifting cultivation, crop rotation and mixed farming of which crop rotation is the commonest.

The responses obtained from farmers reflected a high demonstration of farmers' awareness about the totality of their climatic environment. For instance, Kabba people acknowledged pests as the most significant factor responsible for low crop yield in the area (65%) while climate (26.3%) was ranked next (Table 4). Of these pests, zonocerus was ranked first (74.2%) (Table 5).

Table 4: Reasons for Low Crop Yield

Reason	Nos.	%
Weed	0.3	2.17
Pests	91	65.0
Climate	37	26.3
Poor Seed	09	6.6
Total	140	100

Source: Author's field, work 1995

Table 5: Extent of Damage Done by Each Pest

Pests	Nos.	
Grasshopper	104	74 2
Bird	10	7.1
Rodents	18	12.8
Others	08	5.7
Total	140	100

Source: Author's field, work 1995

It is apparent from table 6 that dry years were perceived to be the worse years of zononcerus infestation (68.3%) while the wet (24.5%) and normal (7.2%) years were noted to be less in severity. In other words, the farmers were able to relate fluctuation of an outbreak to the climatic situation in their environment.

Table 6: Frequency of Pest Outbreak During Normal, Dry and Wet Year

Period	%
Normal year	7.2
Dry year	68.3
Wet year	24.5
Total	100

Source: Author's field, work 1995

When views of the farmers regarding the dates and severity of previous outbreaks were examined, it was observed that about 74% viewed the period between 1973-1988 as a period that witnessed the worst outbreak. The period between 1988 to date and the year before 1973 were perceived to have witnessed less severe and mild outbreak of zonocerus grasshopper respectively (Table 7).

Table 7: Perceived Period of Worst Zonocerus Outbreak in Kabba.

Period	Nos.	%
1988-Present	26	18.7
1973-1988	103	74.1
< 1973	11	7.2
Total	140	100

Source: Author's field, work 1995

The results of the responses were subjected to chi-square test. The result indicates that farmers' views differ significantly at 95% probability level (Table 8). The summary of chi-test performed is presented.

Table 8: Summary of Chi-Test.

Variables	Df	X^2	Prob
Table 4	9	420	0.05
Table 5	9	420	0.05
Table 6	4	200	0.005

$\alpha = 0.05$

Source: Author's field, work 1995

Relationship between Modern Scientific and Indigenous Knowledge

Both indigenous and modern scientific approaches employed in this study indicate that there is an overlap in the areas of frequency of pest outbreak during different years

described as normal, dry and wet and in the historical reconstruction of pest outbreak. On the other hand, the two approaches, indigenous and modern, comparably related fluctuation in outbreak to the climatic situation. Zonocerus outbreak was observed to be more frequent in dry years than in wet years and that duration varies accordingly. The farmers' perception of the frequency of pest outbreak is in broad agreement with the pattern of occurrence for years of mild and severe outbreak already reported. Drought was acknowledged as the main catalyst to grasshopper menace in Kabba area. Indeed, farmers perception of the worst outbreak coincided with the period of low rainfall amount and frequency (26.1mm and 3.0) (Table 3.6).

Table 7 and 9 present the comparison between observed and perceived periods of worst Zonocerus outbreak effect in Kabba. Observed years were 1976, 1978, 1980 and 1982, while perceived years were between 1973 and 1988.

Table 9: Observed Years of Worst Outbreak of Zonocerus Variegarus at Kabba

Severe	Frequency	Mild	Frequency
1976	2	1977	1
1978	2	1979	1
1980	2	1981	1
1982	2	1983	1
–	–	1984	1
–	–	1985	1
–	–	1986	1
–	–	1987	1
–	–	1988	1
Total	8	Total	10

Source: Kwara Agricultural Development Project, Ilorin.

Thus the observed years are subsumed within the range of the years perceived as severe. On the other hand, farmers could not recall vividly the years of mild pest outbreak. While 1977, 1979, 1981, 1983 and 1984-1989 were observed years of mild Zonocerus infestation, the farmers perceived the period before 1973 as the mild years of infestation and the period of 1983 to date was regarded as period of moderate invasion.

Conclusion

The study has examined both the actual and perceived impacts of climate on zonocerus grasshoppers outbreak in Kabba, Kogi state, Nigeria, using both primary and secondary sources of data. Indigenous knowledge was related to modern conclusion and results show that rainfall amount, frequency and sunshine duration are very crucial in determining grasshopper severity any time. The study also indicates that rainfall amount and frequency combine to determine the severity of each stage of zonocerus developments. Thus, severe years were observed to witness late peack of rainfall.

Questionnaire results indicate that the farmers have appreciable knowledge of their climatic environment as farmers perceived dry years as years of his zonocerus infestation of crops. The incidence of pest outbreak and the magnitude of plants devastation are related to drought. For instance, outbreak of zonocerus is highest during the dry years (68.3%) compared with 24.5% during the wet years and 7.2% during the normal years (Table 6).

The principal result of our work indicates that drought encourages outbreak of zonocerus grasshopper. Grasshopper can not be eradicated and need not be eradicated, hence, the competition between man and grasshoppers continues for the available food resources. However, in a game with nature, such as this, man needs to plan his strategies in a way to outwit nature. Thus, whenever drought or/and delay in the start of rainfall is expected, conscious efforts should be made to stimulate farmers' awareness toward controlling the outbreak of the pest.

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