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Seasonal incidence of major insect pests of pigeonpea in relation to weather parameters

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Abstract

The study investigates the seasonal incidence of major insect pests of pigeonpea (*Cajanus cajan*) in relation to weather parameters. Conducted at the experimental farm of the Department of Entomology, Vasantrao Naik Marathwada Krishi Vidyapeeth (VNMKV), Parbhani, Maharashtra, during the kharif seasons of 2021-22 and 2022-23, the research aimed to understand pest dynamics under natural infestation without insecticidal intervention. The pigeonpea variety BDN 13-41 (Godavari) was cultivated across a 100 m² plot, adhering to recommended agronomic practices. Weekly observations were recorded on major pests, including *Grapholita critica*, *Helicoverpa armigera*, *Maruca vitrata*, *Exelastis atomosa*, and *Melanagromyza obtusa*. Larval counts were systematically assessed, and pod fly incidence was determined through the collection and analysis of damaged pods. Weather data were correlated with pest populations using WASP 2.0 software to identify patterns. The results revealed that *G. critica* larvae peaked at 2.72 and 1.98 per plant in October during 2021-22 and 2022-23, respectively. *H. armigera* infestations reached a maximum of 4.36 larvae per plant in December (2021-22) and 4.10 larvae per plant in December (2022-23). *M. vitrata* and *E. atomosa* populations exhibited their highest densities in December, correlating with flowering and pod development stages. The peak maggot density of *M. obtusa* was recorded at 17.20 individuals per 25 pods in January (2021-22). Statistical analysis indicated significant correlations between pest populations and weather parameters, including temperature, humidity, and rainfall. The study underscores the critical role of weather in influencing pest dynamics and highlights the importance of timely, eco-friendly pest management strategies tailored to local climatic conditions.

Keywords: Pigeonpea (*Cajanus cajan*), insect pests, seasonal incidence, weather parameters

Introduction

Pigeonpea scientifically recognized as *Cajanus cajan* (L.) Mill sp., is an agriculturally significant leguminous crop known by various regional names, including "red gram," "tur," or "arhar." It stands as one of India's paramount pulse crops. This versatile crop has garnered attention for its multifaceted contributions and nutritional richness. Pigeonpea stands as a nutritionally formidable crop, boasting an impressive protein content that ranges from 16.2% to 35%. It not only provides a substantial protein source but also excels in its amino acid profile, contributing substantially to dietary diversity. Its dried seeds serve as a staple food source, while both pods and immature seeds are celebrated as delectable green vegetables. The leaves and stems find their purpose as valuable fodder for livestock, and even the dry stems contribute to the provision of fuel. Beyond its immediate nutritional and culinary significance, pigeonpea exhibits its worth in sustainable agriculture. This is achieved through its exceptional capability to enhance soil fertility via nitrogen fixation. The leaf fall and the natural recycling of nutrients also play pivotal roles in this context (Sreekanth *et al.* 2019)^[15]. Pigeonpea holds a unique position as a protein-rich staple, offering a substantial 22% protein contribution to the human diet, nearly tripling that of cereals. It also distinguishes itself with a lower fat content compared to other pulses. Commonly consumed in the form of split pulses or "Dal," pigeon pea complements cereal-based vegetarian diets in an indispensable manner.

India takes the lead in pigeon pea cultivation, boasting a vast expanse of 44.29 lakh hectares, yielding a remarkable 35.69 lakh tonnes, and registering a productivity rate of 806 kg per hectare. Within India, the state of Maharashtra emerges as a focal point for pigeon pea cultivation.

The pigeon pea crop flourishes across 12.61 lakh hectares in Maharashtra, yielding an annual harvest of 8.34 lakh tonnes, with an average productivity of 800 kg per hectare. Notably, the markets of Akola, Jalgaon, Latur, and Nagpur in Maharashtra play pivotal roles in the trade and distribution of this crop, further emphasizing its regional importance. The Marathwada region within Maharashtra significantly contributes to the overall pigeon pea landscape. Covering approximately 4.56 lakh hectares, this region yields an annual production of 3.80 lakh tonnes and maintains an average productivity rate of 789 kg per hectare, as of the 2017-18 agricultural season (Anonymous 2018) ^[1].

Several insect pests are known to infest pigeon pea, with some posing particularly severe threats to its cultivation. Notable among these are gram Pod Borer (*Helicoverpa armigera*), Pod fly (*Melanagromyza obtuse*), Plume Moth (*Exelastis atomosa*) Spotted Pod Borer (*Maruca vitrata*) Blue Butterfly (*Lampides boeticus*), is among the most serious pests, causing substantial harm to both crop yield and quality. According to research by Lal *et al.* (1992) ^[8], pigeon pea crops can suffer substantial yield losses, ranging from 60% to 90% under favorable conditions. Moreover, the damage caused by the pod fly can vary from 14.3% to 46.6%. Notably, a significant portion of this damage, around 60%, is attributed to the combined impact of *Helicoverpa armigera* (Hubner) and *Melanagromyza obtusa* (Malloch), collectively referred to as the "borer complex" (Wadasker *et al.* 2013) ^[19]. This complex of pests has posed a persistent challenge to pigeon pea cultivation. One of the prevailing issues in pigeonpea cultivation is the stagnation in yields over the past three to four decades. This stagnation can be primarily attributed to the substantial damage inflicted by insect pests, which has impeded the crop's potential for increased productivity and improved agricultural outcomes. Due to significant variations in agro-climatic conditions across different regions, pests exhibit diverse patterns in their distribution, occurrence, behavior, and the severity of crop damage they cause. Additionally, certain known and unknown factors may play a crucial role in influencing the prevalence and dominance of specific pests or pest complexes (Meena & Kanwat, 2010; Patel *et al.*, 2009) ^[10, 11]. Understanding the peak periods of pest infestations is essential for implementing effective pest management strategies while minimizing the use of highly toxic chemicals in agricultural fields. Considering these aspects, the current study was conducted to examine the seasonal occurrence of major insect pests of pigeonpea and their relationship with weather parameters such as rainfall, temperature, and relative humidity.

Materials and Methods

The present investigation was carried out within the premises of the experimental farm at the Department of Entomology, VNMKV, Parbhani, during the *kharif* seasons of 2021-22 and 2022-23. The pigeonpea variety BDN 13-41 (Godavari) was grown on an area of 100 m² by adopting the spacing of 90 x 30 cm following the recommended package of practices. The whole plots were exposed to natural infestation and no insecticides applied. The recording observations on population dynamics of pod borer complex

and other pod bugs on plot was divided into four quadrates from each quadrate, five plants were selected randomly and tagged. The larvae of the leaf roller, *Grapholita critica* were recorded from vegetative to flowering stage at weekly intervals. Larval population of *Helicoverpa armigera*, *Exelastis atomosa* and *M. vitrata* was recorded from tagged plants in each plot at weakly intervals. For this, each tagged plant was critically examined and larval stages of the pest were counted right from flowering to harvesting stage of the pigeonpea crop. The incidence of pod fly, *Melanagromyza obtuse* in pigeonpea was recorded based on, 25 green pods were collected periodically from pod formation stage to till harvesting of the crop. Damaged pods were stored out by detecting the presence of maggot or pupa, tunnelled grains inside the pod and small pin hole window were recorded. The data pertaining to seasonal incidence were correlated with weather using WASP 2.0 software.

Results and Discussion

Seasonal incidence of *Grapholita critica* during *kharif* 2021-22 and 2022-23 is graphically presented in Fig. 1. During the 2021-22 season, initial observations noted larval presence during the 36th Standard Meteorological Week (SMW) in September, with an average density of 0.88 larvae per plant. Subsequently, there was a consistent rise in larval numbers until the last SMW in October. The peak density of larvae, reaching 2.72 per plant, was observed in the last week of October (44th SMW). During 2022-23 season, Initially, at the onset during the 36th Standard Meteorological Week (SMW) in September, an average of 0.82 larvae per plant was observed. Following this, there was a steady increase in larval counts until the third SMW in October. The highest density of larvae, peaking at 1.98 per plant, was recorded in the third week of October (42nd SMW). These result inline with results of Chakryavarty *et al.* (2017) ^[2] found that the activity of *G.critica* started during 37th SMW and it attained peak during 41st standard week. Ugale *et al.* (2020) ^[18] observed that population of *G. critica* to the extent of 1.98 larvae/plant was noticed during 42nd SMW, respectively.

Seasonal incidence of *Helicoverpa armigera* during *kharif* 2021-22 and 2022-23 is graphically presented in Fig. 1. During season 2021-22, initial observations recorded the presence of larvae at 42nd (SMW) in October, with an average density of 0.16 larvae per plant. Subsequently, the larval population exhibited a steady increase until the fourth SMW of December. The peak larval density, reaching 4.36 larvae per plant, was observed in the third week of December (51st SMW). In 2022-23 season, larval presence noted during the 40th SMW in October, with an average density of 0.33 larvae per plant. The peak larval density of 4.10 larvae per plant occurred during the 52nd SMW in December. These findings align closely with previously documented data by Keval *et al.* (2017) ^[6] and Chavan *et al.* (2018) ^[3], who also reported a similar onset and continuation of *H. armigera* infestation from the 40th to the 52nd SMW. Chopde *et al.* (2020) ^[4] reported that the maximum infestation of *H. armigera* (Hubner) (18.78%) was observed in 52nd SMW.

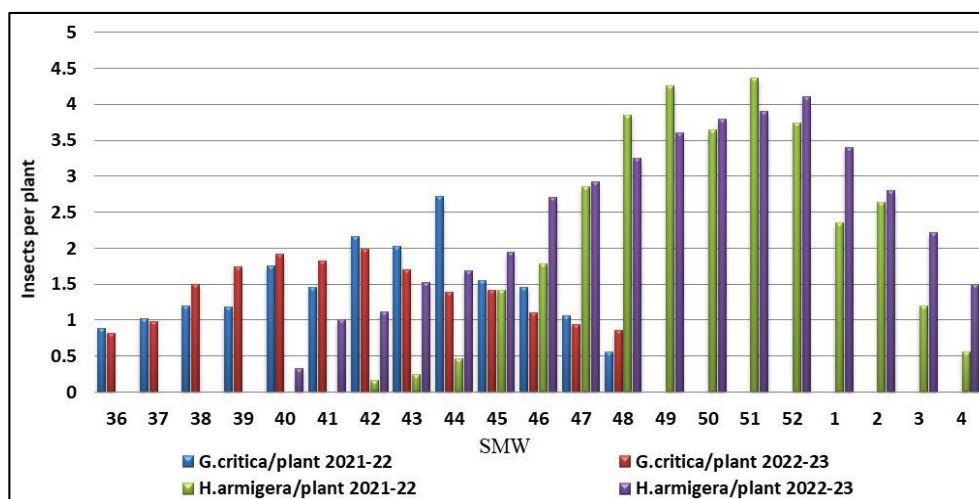


Fig 1: Seasonal incidence of *C. critica* and *H. armigera* during kharif 2021-22 and 2022-23

The trends in *M. vitrata* larval population on pigeonpea fields during 2021-22 and 2022-23 graphically presented in Figure 02. The initial sighting of larvae occurred during the 39th SMW in September, registering an average density of 0.18 larvae per plant. The pinnacle of larval density, at 4.12 larvae per plant, manifested during the initial week of December (49th SMW). During 2023-24 season, initial observations recorded the presence of larvae during the 39th SMW in September, with an average density of 0.13 larvae per plant. The peak larval density, reaching 3.80 larvae per plant, occurred during the concluding week of December (52nd SMW). These observations are notably congruent with the findings of Rodge *et al.* (2019) [13], who reported the presence of *M. vitrata* during the flowering stage (47th to 48th SMW), maintaining activity until crop maturity, with a pinnacle in population density occurring between December (49th SMW) and January (2nd SMW). Similarly, Sreekanth *et*

al. (2019) [15] documented the incidence of *M. vitrata* during the 45th SMW, reaching its zenith during the 50th SMW (December 10-16), aligning with the peak flowering stage of the crop. Moreover, Ugale *et al.* (2020) [18] observed the highest population of *M. vitrata* on pigeonpea, recording 3.80 larvae per plant during the 51st SMW.

Seasonal incidence of *E. atomosa* on pigeonpea fields during 2021-22 and 2022-23, graphically presented in Figure 02. During 2021-22 season, initial observations noted larval presence during the 43rd SMW in October, with an average density of 0.16 larvae/plant. The peak larval density, reaching 3.95 larvae per plant, was observed during the concluding week of December (52nd SMW). During 2022-23, the peak larval density, reaching 2.80 larvae per plant, was observed during the final week of December (52nd SMW).

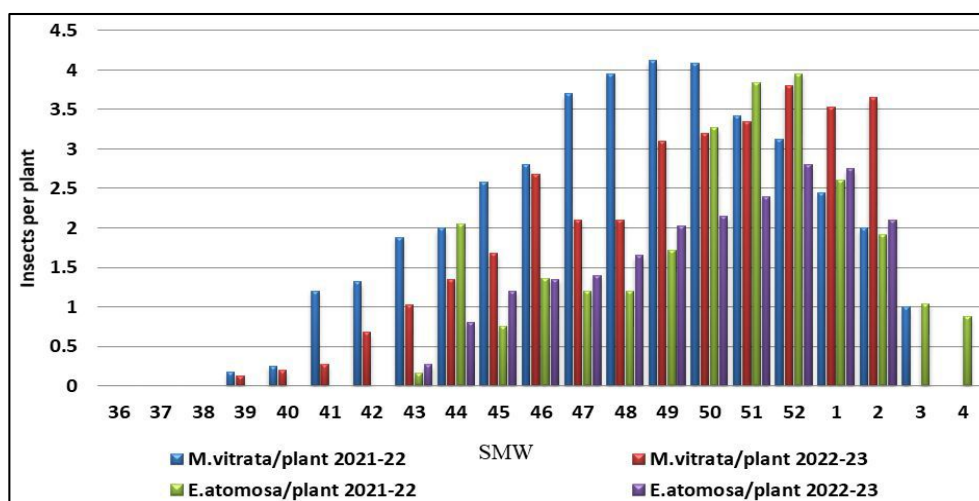


Fig 2: *M. vitrata* larval population on pigeonpea fields during 2021-22 and 2022-23 graphically presented

The temporal dynamics of *M. obtusa* maggot and pupal population on pigeonpea fields during 2021-22 and 2022-23, graphically depicted in Figure 02. During season 2021-22, initial observations revealed the presence of maggot and pupae during the 46th SMW in November, with an average density of 10.54 individuals (maggot and pupae combined) per 25 pods. Subsequently, the population demonstrated a consistent increase until the second SMW of January. The zenith of maggot and pupal density, reaching 17.20

individuals per 25 pods, occurred during the 2nd week of January (2nd SMW). During season 2022-23, initial observations detected maggot and pupae during the 43rd SMW in October, with an average density of 10.09 individuals (maggot and pupae combined) per 25 pods. Subsequently, there was a consistent increase in population size until the second SMW of January. The peak density of maggot and pupae, reaching 16.80 individuals per 25 pods, was recorded during the second week of January (2nd

SMW). The current findings align with previous research conducted by Srinivas *et al.* (2018) ^[16], which documented the activity of the pod fly starting around the 44th Standard Meteorological Week (SMW), reaching its peak during the 8th SMW, with observed larval counts of 36.00 and 30.96 maggot per 50 pods. Rodge *et al.* (2019) ^[13] similarly reported the presence of the pod fly, *M. obtusa*, on crops during the flowering stage (47th to 48th SMW), persisting until maturity, and peaking between December (49th SMW) and January (2nd SMW). Additionally, Chopde *et al.* (2020) ^[4] observed the highest percentage infestation of *M. obtusa* (Malloch) at 18.38 during the 1st SMW.

The data regarding correlation coefficients between weather parameters and the leaf webber population during the 2021-22 and 2022-23 seasons are displayed in Table No. 01. The correlations between the leaf webber population on pigeonpea and various weather parameters during 2021-22, namely rainfall ($r = 0.240$), maximum temperature ($r =$

0.275), minimum temperature ($r = 0.094$), morning relative humidity ($r = 0.301$), evening relative humidity ($r = 0.057$), evaporation ($r = 0.201$), bright sunshine per day ($r = 0.246$), and wind velocity ($r = 0.113$), exhibited positive non-significant correlations. During the 2022-23 season, rainfall ($r = 0.140$), minimum temperature ($r = 0.165$), and morning relative humidity ($r = 0.036$) showed positive non-significant correlations with the leaf webber population. Conversely, evening relative humidity ($r = -0.134$) and wind velocity ($r = -0.227$) displayed negative non-significant correlations. In contrast, maximum temperature ($r = 0.534$), evaporation ($r = 0.402$), and bright sunshine per day ($r = 0.500$) manifested positive and significant correlations with the leaf webber population. The present findings closely align with Kumar *et al.* (2010) ^[7] observations, which highlighted a positive and significant impact of water evaporation on the increase in leaf webber population.

Table 1: Correlation of major insect pests of pigeonpea with weather parameters during *kharif* 2021-22 and 2022-23.

Year	Pest	Rainfall (mm)	Temperature		Humidity		EVP	BSS	WS
			Max	Min.	AM	PM			
Kharif 2021-22	<i>G. critica</i>	0.240	0.275	0.094	0.301	0.057	0.201	0.246	0.113
	<i>H. armigera</i>	-0.513**	-0.283	-0.827**	-0.235	-0.761**	0.176	0.484**	-0.574**
	<i>E. atomosa</i>	-0.458*	-0.354	-0.731**	-0.142	-0.641**	0.125	0.362	-0.496**
	<i>M. vitrata</i>	-0.472*	-0.339	-0.699**	-0.137	-0.600**	0.085	0.308	-0.492**
	<i>M. obtusa</i>	-0.611**	-0.293	-0.945**	-0.296	-0.869**	0.316	0.571**	-0.571**
Kharif 2022-23	<i>G. critica</i>	0.140	0.534**	0.165	0.036	-0.134	0.402*	0.500**	-0.227
	<i>H. armigera</i>	-0.424*	-0.468*	-0.639**	-0.192	-0.575**	0.085	-0.016	-0.194
	<i>E. atomosa</i>	-0.476*	-0.205	-0.574**	-0.267	-0.699**	0.326	0.193	-0.271
	<i>M. vitrata</i>	-0.423*	-0.470*	-0.752**	-0.184	-0.603**	0.095	0.111	-0.260
	<i>M. obtusa</i>	-0.438*	-0.673**	-0.741**	-0.203	-0.522**	-0.039	-0.028	-0.126

In case of *H. armigera*, during season 2021-22, correlation with weather parameters was like, rainfall ($r = -0.513$), minimum temperature ($r = -0.827$), evening relative humidity ($r = -0.761$) and wind velocity ($r = -0.574$) exhibited statistically significant negative correlations. Conversely, maximum temperature ($r = -0.283$) and morning relative humidity ($r = -0.235$) displayed negative correlations that were not statistically significant in relation to the *H. armigera* population. Additionally, evaporation ($r = 0.176$) demonstrated a statistically non-significant positive correlation, while bright sunshine per day ($r = 0.484$) displayed a significant positive correlation. During season 2022-23, the population of *H. armigera* on pigeonpea showed diverse correlations with distinct weather parameters. Notably, rainfall ($r = -0.424$), maximum temperature ($r = -0.468$), minimum temperature ($r = -0.639$) and evening relative humidity ($r = -0.575$) displayed statistically significant negative correlations. However, morning relative humidity ($r = -0.192$), bright sunshine per day ($r = -0.016$) and wind velocity ($r = -0.194$) exhibited negative correlations that were not statistically significant concerning the *H. armigera* population. Additionally, evaporation ($r = 0.085$) indicated a statistically non-significant positive correlation. The findings derived from this experiment align closely with previous studies conducted by Jakhar (2016) ^[5], Keval *et al.* (2017) ^[6] and Chavan *et al.* (2018) ^[3]. These earlier works also observed a significant negative correlation between the minimum temperature and evening relative humidity, mirroring the results obtained in the present investigation. Additionally,

Shinde *et al.* (2017) ^[14] corroborated this research by noting that the larval population of *H. armigera* showed a negatively significant correlation with rainfall.

The correlations between weather parameters and the *E. atomosa* population during the 2021-22 season showed, rainfall ($r = -0.458$), minimum temperature ($r = -0.731$), evening relative humidity ($r = -0.641$) and wind velocity ($r = -0.496$) exhibited statistically significant negative correlations. Conversely, maximum temperature ($r = -0.354$) and morning relative humidity ($r = -0.142$) displayed negative correlations that were not statistically significant in relation to the *E. atomosa* population. Additionally, evaporation ($r = 0.125$) and bright sunshine per day ($r = 0.365$) demonstrated a statistically non-significant positive correlation. During season 2022-23, it was rainfall ($r = -0.476$), minimum temperature ($r = -0.574$) and evening relative humidity ($r = -0.699$), exhibited statistically significant negative correlations. Conversely, maximum temperature ($r = -0.205$), morning relative humidity ($r = -0.267$) and wind velocity ($r = -0.271$) displayed negative correlations that were not statistically significant in relation to the *E. atomosa* population. Additionally, evaporation ($r = 0.326$) and bright sunshine per day ($r = 0.193$) demonstrated a statistically non-significant positive correlation. Consistent results were documented by Landge (2009) ^[9], who noted that maximum temperature, sunshine, and evaporation had an adverse impact on the larval population. Similarly, Rawat *et al.* (2017) ^[12] arrived at the same conclusion. However, contrasting findings were observed by Shinde *et al.* (2017) ^[14], who found a non-significant correlation between rainfall

and the larval population of *E. atomosa*.

Correlations between weather parameters and the population of spotted pod borer during the 2021-22 season revealed that rainfall ($r = -0.472$), minimum temperature ($r = -0.699$), evening relative humidity ($r = -0.600$) and wind velocity ($r = -0.492$). Conversely, negative correlations were found for maximum temperature ($r = -0.339$) and morning relative humidity ($r = -0.137$), although these correlations were not statistically significant concerning the Spotted pod borer population. Furthermore, both evaporation ($r = 0.085$) and bright sunshine per day ($r = 0.308$) displayed statistically non-significant positive correlations. During season 2022-23, statistically significant negative correlations were observed for rainfall ($r = -0.423$), maximum temperature ($r = -0.470$), minimum temperature ($r = -0.750$) and evening relative humidity ($r = -0.603$). Conversely, negative correlations were found for and morning relative humidity ($r = -0.184$) and wind velocity ($r = -0.260$) although these correlations were not statistically significant concerning the Spotted pod borer population. Furthermore, both evaporation ($r = 0.095$) and bright sunshine per day ($r = 0.111$) displayed statistically non-significant positive correlations. The current study aligns with Sreekanth *et al.* (2019) ^[15] findings, highlighting a notable correlation between *M. vitrata* and both minimum temperature and evening relative humidity. Additionally, Tagger *et al.* (2019) ^[17] documented a positive influence of maximum temperature on the larval population.

The correlations between weather parameters and the pod fly population during the 2021-22 season revealed that rainfall ($r = -0.611$), minimum temperature ($r = -0.945$), evening relative humidity ($r = -0.869$) and wind velocity ($r = -0.571$) exhibited statistically significant negative correlations. Conversely, maximum temperature ($r = -0.293$), morning relative humidity ($r = -0.296$) and evaporation ($r = 0.316$) displayed negative correlations that were not statistically significant in relation to the pod fly population. Additionally, bright sunshine per day ($r = 0.571$) demonstrated a statistically significant positive correlation. During season 2022-23, statistically significant negative correlations were observed for rainfall ($r = -0.438$), maximum temperature ($r = -0.673$), minimum temperature ($r = -0.741$) and evening relative humidity ($r = -0.522$). Conversely, morning relative humidity ($r = -0.203$), evaporation ($r = 0.039$), bright sunshine per day ($r = 0.028$) and wind velocity ($r = -0.126$) exhibited negative correlations that did not reach statistical significance concerning the pod fly population. The present findings align with earlier studies such as Keval *et al.* (2017) ^[6], who noted a significant negative correlation between the maximum incidence of *M. obtusa* and relative humidity. Similarly, Shinde *et al.* (2017) ^[14] found a negative correlation between maggot population and maximum temperature, a result echoed by Srinivas *et al.* (2019) ^[16] who observed significant negative correlations between pest population and various temperature and humidity variables minimum and average temperature, morning, evening, and average relative humidity.

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Authors Contribution Statement

Mahesh V. Ugale, Sanjeev D. Bantewad and Shubham H. Gore conceptualized and designed the study, conducted the study, analyzed the data, and authored the report under the supervision of Sanjeev D. Bantewad.

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Conflict of Interest

No conflict of interest.

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