Ringkasan

PENGENDALIAN HAMA BELALANG KEMBARA (*Locusta migratoria*) DENGAN MENGGUNAKAN GELOMBANG ULTRASONIK DI KALIMANTAN BARAT

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Belalang kembara (*Locusta migratoria*) yang termasuk dalam genus *Locusta* mempunyai beberapa sub-spesies yang wilayah penyebarannya berbeda-beda. Di Indonesia, *Locusta migratoria manilensis* merupakan satu-satunya spesies belalang yang mengalami fase transformasi dari sebanyak 51 spesies anggota famili *Acrididae* yang tercatat sebagai hama di Indonesia. Struktur tubuh belalang kembara terdiri dari tiga bagian yaitu kepala (caput), dada (thorax) dan perut (abdomen), mempunyai satu pasang antena, dua pasang sayap dengan tiga pasang kaki.

Belalang kembara dalam kehidupannya berjalan, berpindah dan berputar dengan menggunakan kaki serta terbang dengan menggetarkan sayap. Belalang kembara memiliki alat indra mata, telinga dan kumis yang digunakan sebagai antena. Alat indra tersebut berfungsi untuk mengatur sistem perpindahan, informasi serta komunikasi antara belalang kembara jantan dan betina dalam perkembangbiakannya. Berdasarkan pengamatan dan literatur komunikasi sesama belalang kembara ini berada pada rentang frekuensi puluhan kilo hertz dan merupakan jenis gelombang ultrasonik.

Gelombang ultrasonik (*Ultrasonic waves*) merupakan gelombang mekanik longitudinal dengan frekuensi di atas 20 kHz yaitu daerah batas pendengaran manusia. Gelombang ultrasonik dapat merambat dalam medium padat, cair dan gas. Hal ini disebabkan karena gelombang ultrasonik merupakan rambatan energi dan momentum mekanik, rambatan energi ini berinteraksi tergantung pada molekul dan sifat inersia medium yang dilaluinya.

Hama belalang kembara merupakan hama jenis serangga yang menjadi kendala dan masalah bagi masyarakat/petani di Indonesia, khususnya masyarakat/petani di Kabupaten Ketapang Propinsi Kalimantan Barat. Siklus kehidupan belalang kembara ini dimulai dari fase soliter, fase transsien sampai pada fase gregaria.

Perkembangbiakan populasi belalang kembara terjadi akibat dari perubahan iklim dengan curah hujan rata-rata 177,9 mm/th dengan hari hujan 11,3 kali/bulan, suhu rata-rata berkisar 23,6 ^{0}C – 26,8 ^{o}C dan pada siang hari rata-rata mencapai 31,1 ^{O}C. Jika populasi belalang kembara ini sagat tinggi, maka dapat menyerang tanaman holtikultura (padi. jagung dan sayur-sayuran) sampai dengan tanaman kelapa sawit. Pada tahun 1999 serangan hama belalang kembara mencapai 9 kecamatan di kabupaten Ketapang dengan luas daerah serangannya mencapai 4420 ha daerah pertanian dan perkebunan.

Penelitian ini merupakan suatu penelitian eksperimental laboratoris dengan pendekatan biofisika. Manfaat dari penelitian ini adalah untuk memberi informasi model alternatif atau metode baru proses Pengendalian

Hama Terpadu (PHT) secara mekanis/fisika dengan prinsip ramah lingkungan dan tidak menimbulkankan pencemaran dengan menggunakan alat pembangkit gelombang ultrasonik.

Pengendalian hama belalang kembara adalah menghilangkan atau mengurangi aktivitas daya rusak hama terhadap tanaman. Pada penelitian ini aktivitas tersebut dibatasi pada pola perilaku makan pasif dan gerak pasif.

Penelitian ini dilaksanakan mulai dari rancang bangun piranti elektronik untuk menghasilkan sumber pembangkit frekuensi gelombang ultrasonik. Hasil pembuatan piranti elektronik alat pembangkit frekuensi gelombang ultrasonik ini, menghasilkan frekuensi yang dapat diatur dari 20 kHz sampai 60 kHz dengan jarak jangkauan pancaranya mencapai kira-kira 20 meter.

Eksperiment laboratorim dilakukan untuk mempelajari karakteristik belalang kembara serta responnya terhadap gangguan dari gelombang ultrasonik terhadap pola perilaku makan pasif dan gerak pasif belalang kembara. Dari hasil ekperimen laboratorim dengan skala kecil ini akan diperoleh data pola perilaku makan pasif dan gerak pasif belalang kembara yang selanjutnya dapat diperluas menjadi penerapan dan pengendalian hama belalang kembara di lapangan dan pada akhirnya dapat disosialisasikan ke masyarakat.

Penelitian dilakukan dengan hipotesis bahwa : 1). Fekuensi gelombang ultrasonik optimal berpengaruh terhadap pola perilaku makan pasif dan gerak pasif belalang kembara. 2). Jarak sumber gelombang ultrasonik optimal berpengaruh terhadap pola perilaku makan pasif dan gerak pasif belalang kembara. 3). Lama pemaparan gelombang ultrasonik optimal berpengaruh terhadap pola perilaku makan pasif dan gerak pasif belalang kembara. 4). Kombinasi antara frekuensi, jarak sumber dan lama pemaparan gelombang ultrasonik optimal berpengaruh terhadap pola perilaku makan pasif dan gerak pasif belalang kembara.

Untuk menguji kebenaran dari hipotesis ini, dirancang percobaan di laboratorium dengan memaparkan gelombang ultrasonik terhadap belalang kembara dengan frekuensi, jarak dan lama pemaparan dibuat berbeda-beda. Frekuensi yang digunakan dalam penelitian mulai dari 40 kHz, 45 kHz, 50 kHz dan 55 kHz, jarak sumber dari 100 cm, 200 cm, 300 cm dan 400 cm serta lama pemaparan mulai dari 1 jam, 2 jam, 3 jam dan 4 jam. Jenis belalang kembara untuk penelitian ini merupakan belalang dewasa dari fase soliter yang umurnya rata-rata 3 bulan dan panjang belalang kembara jantan 4 cm dan betina 5 cm yang diambil dari tempat penangkaran dinas pertanian Kabupaten Ketapang. Data pengamatan respon dan perubahan pola perilaku makan pasif dan gerak pasif belalang kembara akibat adanya permaparan gelombang ultrasonik ini, dianalisis dan digunakan untuk menentukan parameter mana yang paling tepat untuk mengganggu pola perilaku makan pasif dan gerak pasif belalang kembara

Dari hasil pengamatan dan analisis variansi data yang diperoleh dari eksperimen di laboratorium perlakuan gelombang ultrasonik terhadap pola perilaku makan pasif dan gerak pasif belalang kembara dapat diidentifikasikan seperti berikut:

1. Frekuensi gelombang ultrasonik memberikan pengaruh yang bermakna terhadap pola makan pasif dan pola gerak pasif belalang kembara ($P < 0.05$). Frekuensi 50 kHz memberikan nilai optimal untuk pola

perilaku makan pasif 84,74 % dan pola gerak pasif 66,46 % dan berbeda bermakna dengan frekuensi lainnya.

2. Jarak sumber gelombang ultrasonik memberikan pengaruh yang bermakna terhadap pola makan pasif dan pola gerak pasif belalang kembara ($P < 0.05$). Pada jarak sumber 100 cm memberikan nilai optimal untuk pola perilaku makan pasif 67,29 % dan pola gerak pasif 55,83 % dan tidak berbeda bermakna dengan jarak sumber 200 cm dan jarak sumber 300 cm untuk pola gerak pasif.
3. Lama pemaparan gelombang ultrasonik 3 jam – 4 jam memberikan pengaruh yang bermakna terhadap pola makan pasif dan pola gerak pasif belalang kembara ($P < 0,05$). Pola perilaku makan pasif memberikan nilai optimal 68,96 % pada lama pemaparan 3 jam dan tidak berbeda bermakna dengan lama pemaparan 4 jam. Pola perilaku gerak pasif memberikan nilai optimal 61,25 % pada lama pemaparan 4 jam dan tidak berbeda bermakna dengan lama pemaparan 3 jam.
4. Kombinasi frekuensi, jarak sumber dan lama pemaparan gelombang ultrasonik berpengaruh bermakna terhadap pola makan pasif dan pola gerak pasif. Kombinasi optimal pada frekuensi 50 kHz, jarak sumber 100 cm dan lama pemaparan 3 jam – 4 jam. Pada pola perilaku makan pasif 96,66 % -100,0 % dan pola perilaku gerak pasif 96,66 %.

Hasil penelitian ini dapat disimpulkan bahwa frekuensi gelombang ultrasonik 50 kHz, dengan jarak sumber 100 cm dan lama pemaparan 3 jam – 4 jam berpengaruh bermak terhadap pola perilaku makan pasif dan gerak pasif belalang kembara.

Penelitian pemaparan gelombang ultrasonik terhadap pola perilaku makan pasif dan gerak pasif belalang kembara di laboratorium ini, merupakan hasil dasar untuk melakukan usaha pengendalian dan penerapannya di lokasi terjadinya serangan hama belalang kembara.

SUMMARY

THE CONTROL OF MIGRATORY LOCUST PEST *(Locusta migratoria)* BY UTILIZING ULTRASONIC WAVES IN WEST KALIMANTAN

Stepanus Sahala S.

Migratory locusts that belong to genus *Locusta* have several sub-species whose area of distribution varies. In Indonesia, *Locusta migratoria manilensis* is the only locust species that undergoes transformation phase from among 51 species of the *Acrididae* family members, which is regarded as pest in Indonesia. Migratory locust body consists of three parts, i.e., head (*caput*), thorax and abdomen; has a pair of antennae, two pairs of wings and three pairs of feet.

The migratory locusts in their life walk, move and turn around using their feet and fly by vibrating their wings. The migratory locusts have sense organs as eyes, ears and "moustache" that they use as antennae. These sense organs have function to regulate the systems of movement, information and communication between male and female migratory locust in the reproduction process. Based on observation and literature, the communications among migratory locust occurs in frequency range of tens of kilo hertz and belong to ultrasonic waves above 20 kHz range.

The migratory locusts are insect type pest that become impediment and nuisance to farmer community in Indonesia, especially farmer community in Ketapang Regency in West Kalimantan Province. The life cycle of migratory locusts begins with solitary phase, transient phase to gregarious phase.

The population breeding of migratory locusts is brought about by climatic change with average annual rainfall of 177.9 mm with monthly rainy day of 11.3, average temperature range of 23.6 °C – 26.8 °C and reaches average temperature of 31.1 °C on the days. If the population of migratory locusts were too high, it could strike horticultural plants (rice, corn and vegetables), even oil palm trees. The extent of migratory locusts attack could reach thousands hectares of agricultural and plantation areas. In 2000 the attack of migratory locusts reached nine districts in Ketapang Regency with the area of attack reached 4,420 ha of agricultural and plantation estates.

The effort to control migratory locusts pest either by the local government of Ketapang Regency or the farmer community has been done by spraying insecticides that surely could damage the environment and bring about pollution, or by massive catching and hunting. This control was carried out in many places of migratory locusts nesting/flocks in high populations from several life stadiums in migratory locusts droves.

This research was a laboratory experimental study with biophysical approach. The objective of this research is to determine or develop an alternative model or a new method in the process of Integrated Pest Control (IPC) mechanically/physically with environment-friendly and non-polluting principles to control migratory locusts pest by utilizing ultrasonic wave frequency generator.

The control of migratory locust is to eradicate or to decrease the destrucctive power activities of the pest on plants. In this research, the activities were limited to the patterns of pasive movement behaviors.

This research was carried out beginning with the design of electronic instrument to produce ultrasonic wave generating source up to the implementation of testing the impact of electronic waves on migratory locusts in laboratory.

Laboratory experiments were done to study the characteristics and behavior patterns of migratory locusts and their response toward ultrasonic waves' disturbances. From this small-scale laboratory experiments, it would obtain data on behavior pattern of migratory locusts that further could be extended in the future to field application and in turn it would be socialized into the community

The research was implemented with the hypotheses that: 1). Frequencies of ultrasonic waves optimal have effects on pattern behavior pattern that covered passive feeding and passive movement of migratory locusts. 2). Ultrasonic wave source distances optimal affect on pattern that covered passive feeding and passive movement of migratory locusts. 3). Exposure time of ultrasonic waves optimal affect on pattern that covered passive feeding and passive movement of migratory locusts. 4). Combinations of frequency, distance and exposure time of ultrasonic waves optimal affect on pattern behavior pattern that covered passive feeding and passive movement of migratory locusts.

To examine the validity of this hypothesis, laboratory experiments were designed to irradiate ultrasonic waves on migratory locusts taken from solitary phase, in which the frequency, distance and exposure time were differently designed. The research was implemented frequency of 40 kHz, 45 kHz, 50 kHz and 55 kHz, distances of ultrasonic wave source of 100 cm, 200 cm, 300 cm and 400 cm, and exposure times of ultrasonic wave of 1 hours, 2 hours, 3 hours and 4 hours. The data on the observation of response and change of behavior pattern of migratory locusts brought about by ultrasonic wave disturbances were analyzed and employed to determine which parameter were the most dominant to disturb the behavior pattern of the migratory locusts.

From the results of observation and data variation analysis obtained in the laboratory on the treatment of ultrasonic waves on migratory locusts to find out the change of behavior pattern that covered passive feeding and passive movement patterns, it could be identified as follows:

1. Frequencies ultrasonic waves gave significant effects on passive feeding and passive movement patterns ($P < 0.05$). Frequency of 50 kHz gave the optimal values, either for feeding pattern 84,74 % or for movement pattern 66,46 % of the migratory locusts and significantly different from other frequencies.
2. Distances of ultrasonic wave source gave significantly effects on passive feeding and passive movement patterns of the migratory locusts ($P < 0.05$). The distance of 100 cm gave the optimal values for feeding pattern 67,29 % and for movement pattern 55,83 % and was not significantly different from those with 200 cm and 300 cm source distances for movement pattern.
3. Exposure times 3 – 4 hours gave significant effect on passive feeding and passive movement patterns of migratory locusts ($P < 0.05$). Exposure time of 3 hours gave the optimal value for feeding pattern 68,96 % and was not significantly different from that of 4 hours whereas exposure time of

4 hours gave the optimal value for movement pattern 61,25 % and was not significantly different from that of 3 hours.

4. Combinations of frequency, source distance and exposure time of ultrasonic waves gave significant effects on passive feeding and passive movement patterns. The optimal combination with frequency of 50 kHz, distance of 100 cm and exposure time of 3 – 4 hours for passive feeding pattern was obtained with the optimal value 96,66 % - 100,0 % and for passive movement 96,66 %.

It can be concluded from the results of this research that ultrasonic wave with 50 kHz frequency, distance of 100 cm and exposure time of 3 – 4 hours significantly affected behavior pattern passive feeding and passive movement of migratory locusts.

The research of ultrasonic wave exposure on this behavior pattern of passive feeding and passive movement of migratory locust in the laboratory, then a technique of is effort to basics results and to implement against migratory locusts attacks in the location could be carried out.

Abstract

THE CONTROL OF MIGRATORY LOCUST PEST *(Locusta migratoria)* BY UTILIZING ULTRASONIC WAVES IN WEST KALIMANTAN

Stepanus Sahala S.

The objective of this research is to develop new alternative or method in the process of controlling migratory locust pest by utilizing ultrasonic waves. This research was carried out at beginning with the design of electronic instrument to produce ultrasonic waves generating source up to the implementation of laboratory tests.

Laboratory experiments were done to study the characteristics and behavior patterns of migratory locusts and their response toward ultrasonic waves disturbances targeted on the migratory locust. From this small-scale laboratory experiments, it is to be extended in the future to field application and in turn it would be socialized into farmer community.

This research was implemented with the hypothesis that there is an effect of ultrasonic wave exposure at certain frequency, source distance and exposure time and its interaction toward behavior patterns of migratory locusts. To examine the validity of this hypothesis, experiments were designed to irradiate ultrasonic waves on migratory locusts in which the frequency, distance and exposure time were differently designed.

The data on the observation of response and change of behavior patterns that covered the patterns of passive movement and of passive feeding of the migratory locusts brought about by ultrasonic wave disturbances were analyzed and employed to determine which parameter were the most dominant among variations of frequency, exposure distance and exposure time of the ultrasonic waves.

The result of research gave significant differences ($P<0.05$) of the effect of ultrasonic wave frequency, source distance and exposure time. At 50 kHz frequency, it already gave effective impact toward behavior patterns that covered the patterns of passive feeding and passive movement of the migratory locusts.

At this 50 kHz frequency, with exposure time of three to four hours at 100 cm distance it has already effective impact toward the behavior patterns of migratory locusts compared to the change of source distance longer than 100 cm at other frequencies towards passive feeding and passive motion pattern of migratory locusts.

Key words: *Locusta migratoria, ultrasonic frequency, behavior*