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IMPACT OF TEMPERATURE AND RELATIVE HUMIDITY ON DEVELOPMENT OF ZYGOGRAMMA BICOLORATA .

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ABSTRACT

Parthenium hysterophorus, commonly known as carrot weed, native of Central America, is one of the first seven most dangerous weeds of the world. It shows strong allelopathic potential and replacement of native species along with health hazards to humans and animals. To control this noxious weed instead of using chemical weedicides, a cost effective and environmentally safe method through the release of a biological control agent (insect), Zygogramma bicolorata has been practiced. During the present investigation the effect of temperature and relative humidity was studied on the development of Mexican beetle (Zygogramma bicolorata). The developmental stages of Mexican beetle were studied under controlled conditions of temperature and relative humidity (20ºC, 65%; 24 ºC, 70%; 28ºC, 75%, 32 ºC,80%) reared on weed Parthenium hysterophorus. The aim of the study was to analyze the effect of temperature and relative humidity on Z. bicolorata so that mass multiplication can be done efficiently. Studies revealed that maximum development, fecundity and survival were recorded at 28 ºC and 75% RH. Four larval instars were seen and first stage instars were most fortified and defenseless while 3rd and 4th instars were least fortified. Lower temperature (20 ºC) and low humidity (65%) do not favor the mass multiplication and beetle showed diapause behavior, while maximum fecundity and survival was at 28 ºC, 75% RH. This study also established that percentage larval instars life span was almost same at all the temperatures and relative humidity but the duration of pupation was 12-16 days at 20 ºC, 65% RH and 32 ºC and 80% RH, while it was only 9-12 days at 28 ºC, 75% RH.

Key Words; Zygogramma Bicolorata , Mexican Beetle, Parthenium Hysterophorus.

I. INTRODUCTION

Ever since *Parthenium hysterophorus L.* (Asteraceae) introduced in India has become one of the most dangerous weed of wasteland, forestland, along roadside along railway tracks, agriculture land and over grazed pasture lands. It is a fast maturing annual short lived perennial herb with a deep tap root. It may eventually reach a height of 2m. leaves are pale green, branched and covered with soft fine hairs. The weed has strong allelopathic potential (Kanchan and Jayachandra 1980; Singh et al 2002) Persistent soil seed production (Pandey and Dubey 1988) and phenotypic plasticity in growth form (Annapurna and Singh 2003). Invasion of this weed has replaced native species and inturn native diversity has been affected (Grice 2006, Timisina et al 2011) and increased health hazard to animal and human (McFadyen 1995). Parthenium may cause various diseases such as

IJARSE
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dermatitis, hay fever, asthma, bronchitis in human and livestock (Navie et al 1996, Evan 1997, Bhowmik et al 2007), increased labor in agriculture bitter taste in milk (Karki 2009) tainting in mutton (Tudor et al 1981, Tower and Subba Rao 1992). Ever since efforts are being made to manage the weed by different methods but so far no single method has been proved satisfactory as each method suffers from one or more limitation such as temporary relief, environmental safety, impartibility and high cost. To control this noxious weed instead of using chemical weedicide a cost effective and environmentally safe method through the release of biological control agent (insect) *Zygogramma bicolorata* has been practiced. During the present investigation the impact of temperature and relative humidity was studied on the development of *Zygogramma bicolorata* as there always lies a lack of synchronization between *Parthenium hysterophorus* germination and development of beetle.

II. MATERIALS AND METHOD

Laboratory experiments were conducted to investigate the development of *Z. bicolorata* under controlled conditions of temperature and relative humidity (20 ± 1^0C, 65% R.H. ; 24 ± 1^0C, 70% R.H. ; 28 ± 1^0C, 75% R.H. ; 32 ± 1^0C, 80% R.H.) at Government College, Kota. A nucleus culture was obtained from NRCWS, Jabalpur and rearing and multiplication methods of beetles were also learned through training. To study the development of *Z. bicolorata*, 25 boxes with net were taken. Fresh leaves of *Parthenium* were placed after washing thoroughly under tap water and excess of moisture was removed by keeping blotting paper at the floor of netted box. Single egg of *Z. bicolorata* was placed on the fresh *Parthenium* leaf in each box and daily observations were recorded. Incubation period was noted on the basis of daily observation. In the same way larval duration was also studied by keeping the 1^{st} stage instars in larval cage with 1 meter long *Parthenium* plant and larval period was noted. This process was continued till the larvae reached the last instars stage. Once the last instar started showing sluggish behaviour, it was kept in another pupal box (a netted box with moist soil) as pupa requires moist soil to undergo pupation. (Jayanth and Bali, 1995). The date and time of the instars to make pupal chamber and get into it, was recorded. Observation of the pupal period was studied from the date of pupation to the emergence of adult. Total development period from egg incubation to emergence of adult was noted. Study of the fecundity and longevity of female beetles **:** 10 pairs of freshly emerged adult beetles were taken for studying fecundity and adult longevity. The pairs were reared in the earthen pot with full grown *Parthenium* plants covered with mosquito net and tightened by string and adults were allowed to mate. Mating pairs were observed minutely and duration of oviposition and post-oviposition was noted. Number of eggs laid by single female per day was counted and then the eggs were gently transferred in the incubation boxes with the help of fine brush. This process was continued till the egg laying lasted. During this period feeding behaviour was also recorded. Total number of eggs laid by single female in entire life was counted. Similarly, longevity of males and females was also noted from the day of emergence till its death. This experiment was carried out under the four different conditions of temperature and relative humidity. (20^0C, 65%; 24^0C, 70%; 28^0C, 75%; 32^0C, 80%). 15 egg laying boxes with fresh *Parthenium* leaves were used to study number of eggs hatched and percentage of hatching. 50 eggs were placed in each box. Observations were recorded accordingly. Once hatching was recorded the newly hatched larvae were placed in other larval rearing boxes and side by side larval behaviour was observed till they reached pupation. Observations were made on the number of larvae pupated and percent of pupation. After

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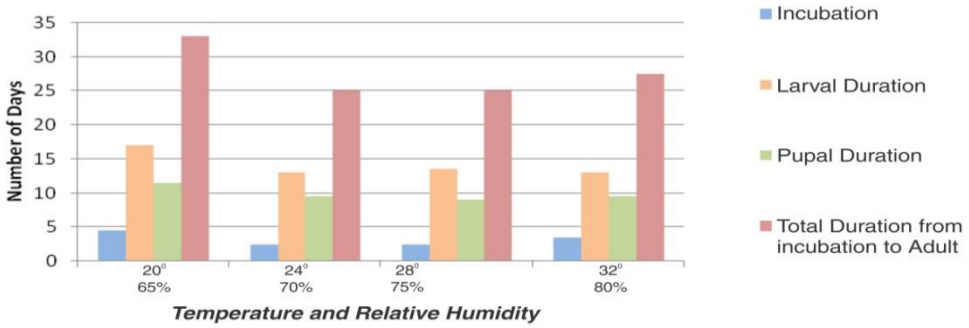
pupation observations were made to study the number of adult emerged and percent of emergence (from the same eggs which have undergone pupation).

Table-1: Biological parameters of *Z. bicolorata* development at selected temperature and relative humidity range.

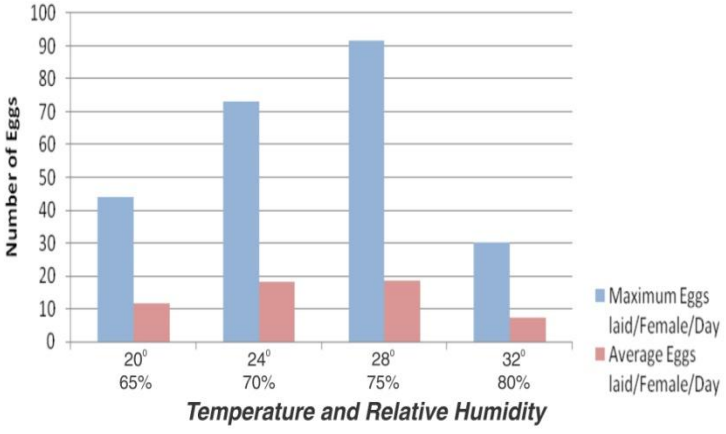
Temperature (°C)	Relative Humidity (%)	Incubation (Days)	Larval Duration (Days)	Pupal Duration (Days)	Total Duration from Incubation to Adult (Days)
20	65	4.5	17	11.5	33
24	70	2.5	13	9.5	25
28	75	2.5	13.5	9	25
32	80	3.5	13	9.5	27.5



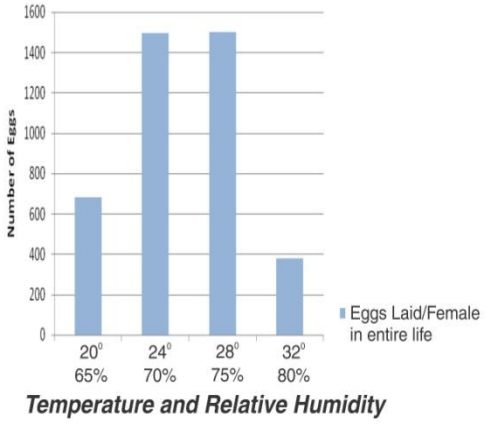
Graph - 1 : Biological parameters of *Z. bicolorata* development at selected temperature and relative humidity range.

Table-2: Fecundity and Longevity of *Z. bicolorata* at selected temperature and relative humidity range.

Temperature (°C)	Relative Humidity (%)	Maximum Eggs Laid/Female/Day	Average Eggs Laid/Famale/Day	Eggs Laid/Female in Entire Life	Longevity (Male)	Longevity (Female)
20	65	44	11.5	681	103	58
24	70	73	18.24	1496	180	82
28	75	91.5	18.5	1501.5	198	82.5
32	80	30	7.18	381	93	53



Graph - 2 : Eggs laying capacity of *Z. bicolorata* at selected temperature and relative humidity range.



Graph - 3 : Eggs laid by single female of *Z. bicolorata* in entire life at selected temperature and relative humidity range.

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Table - 3 : Percent hatching, % pupation and % emergence of *Z. bicolorata* at selected temperature and relative humidity.

Temperature (°C)	Relative Humidity (%)	Percent Hatching	Percent Pupation	Percent Emergence
20	65	46	57	61.92
24	70	84	83	86
28	75	92	84.34	87.62
32	80	42	37.14	67.52

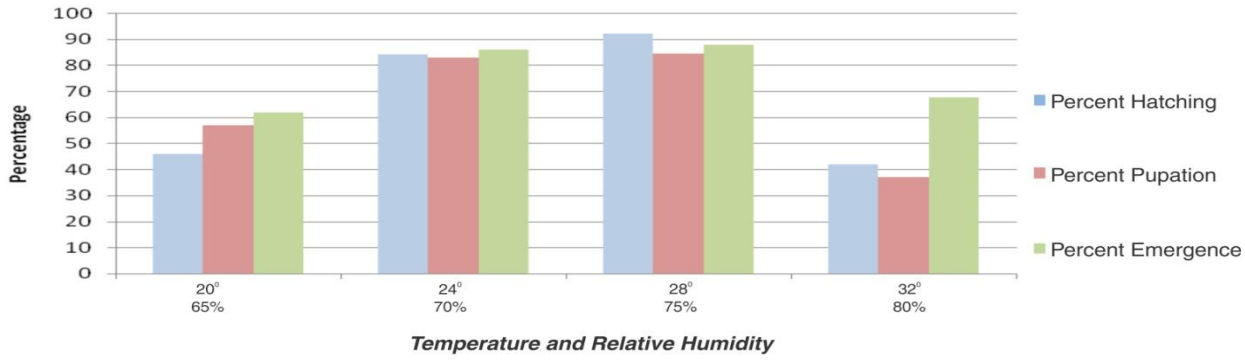

Table - 3 : Percent hatching, % pupation and % emergence of *Z. bicolorata* at selected temperature and relative humidity.

III. RESULT AND CONCLUSION

Development, fecundity, longevity and percent survival of beetles were tested at various temperatures and relative humidity ranges. It was found at development of beetles had maximum probability at the temperature 27.3^{0}C and 76% R.H. It was found that egg laying capacity that is fecundity of beetle had the maximum probability at the temperature of 27.5^{0}C and 73% R.H. The longevity of male beetles had the maximum probability at 26.2^{0}C and 75% R.H. and the longevity of female had maximum probability at 27.8^{0}C, 75% R.H. The result showed that maximum probability of percent hatching was found at 27^{0}C and 75% R.H. The maximum probability of percent pupation was recorded at 25.4^{0}C and 74% R.H. It was concluded that maximum probability of percent emergence was at 28^{0}C and 75% R.H. Concluding remark : The temperature around 27.5^{0}C is the best suitable temperature for all the biological parameters and 75% relative humidity is the best suitable R.H. for all the biological parameters of *Z. bicolorata* studied in the present investigation. The present study revealed that *Parthenium hysterophorus* has been influencing the diversity of native species in two ways. Firstly above the ground vegetation and secondly soil seed bank of *Parthenium*. It also reflects that deadly weed weakens the pasture carrying capacity and reduces live stock productivity. The research throws light on the fact that Mexican beetle *Z. bicolorata* is one of the most effective biological control for *Parthenium hysterophorus*. All the instars and adult beetles were voracious and could nibble the plant completely Hence *Z. bicolorata* has been found efficient enough to defoliate the *Parthenium*, overall reduction in its flowering and plant height reducing overall pollen density in the surrounding area. A large population of beetles resulted in repeated defoliation over a period of 3-4 years, which favoured the germination of native vegetation. Thus for large scale defoliation of *Parthenium hysterophorus* augmentative release of beetles in infested areas could be suggested. The life cycle of the beetle is simple and has enormous capacity of egg laying hence, can be multiplied in the laboratory conditions also easily. Through the studies on effect of temperature and relative humidity on *Z. bicolorata* it could be concluded that maximum development, fecundity and survival were found

IJARSE
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at 28^0C temperature and 75% R.H. Four larval instars were seen. First stage instars were more fortified and defenseless while 3rd and 4th instars were least fortified. Lower temperature (<20^0C) and lower relative humidity (<60% R.H.) did not favour the mass multiplication and beetle showed diapause behaviour. It was also concluded that extreme winters and summers (unfavorable conditions) favour the diapause as the beetle is unable to cope with them. In such situation the mass multiplication, survival and nature of damage which *Z. bicolorata* could cause to *Parthenium* were minimized.

IV. DISCUSSION

Omkar *et al* (2007) studied the effect of different constant temperatures on life history stages of *Z. bicolorata* feeding on weed *Parthenium*. They found that percent life span spent by immature stage was similar across all five temperatures (20, 25, 27, 30 and 35^0C) and they found that 27^0C was most suitable temperature under controlled abiotic conditions for propagation of *Z. bicolorata*, a biocontrol agent for *Parthenium*. Present study also established that larval duration was almost same at all the temperatures (20-32^0C) and relative humidity (65-80%). But maximum fecundity and percent survival ie. hatching, pupation and emergence were recorded between 24-28^0C temperature and 70-75% R.H. Jayanth and Bali (1993b) found that eggs of *Z. bicolorata* failed to hatch at 40^0C and only 4% hatching took place at 15^0C and 16% hatching at 35^0C. In the present study it was observed that percent hatching decreased when the temperature was below 20^0C and above 32^0C, which clearly showed that maximum percent of hatching ranged between these two temperatures. Present study also established that 24^0C-28^0C temperature and 70-75% R.H. are the best suitable ranges of temperature and relative humidity for mass multiplication of beetles, *Z. bicolorata* under laboratory conditions. Mahna and Sharma (2005) studied the biology of the Mexican beetle *Z. bicolorata* on *Parthenium* under controlled conditions (27^0C, 75% R.H.) and they came to a conclusion that a single female laid on an average 18.4±1.26 eggs per day. The total number of eggs laid by a single female in its life time ranged from 1139 to 1602. In the present study under controlled conditions (28^0C, 75% R.H.) eggs laid by a single female in its life time ranged between 1468-1534 with average of 18.24 eggs per day. Dhanokar *et al* (2000) found that females lived longer than males with an average of 49 days while on contrary to their finding in the present studies the males lived longer than the females on all the four constant temperatures and relative humidity in laboratory conditions. Jayanth and Bali (1993[a]) and Pandey *et al* (2001) also supported the present finding of longevity, where males lived for (mean 146) days and females for (mean 129.30) days. Results of Kumar and Chaudhari (2005) showed that climatic conditions especially maximum and minimum temperature and relative humidity affect the population dynamics of the beetles. Present study also revealed that maximum and minimum temperature and relative humidity affected the development and mass multiplication of beetle.

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IJARSE
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