BIONOMICS OF *ALCIDODES SIGNATUS* BOHEMAN (COLEOPTERA: CURCULIONIDAE), A SERIOUS PEST OF GREEN BEAN, *PHASEOLUS VULGARIS* L. FROM UDHAMPUR DISTRICT OF JAMMU (J&K, INDIA)

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ABSTRACT: *Alcidodes signatus* Boheman has been recorded as a serious pest of bean with adults feeding externally on the soft parts of the plant and larvae feeding internally and inducing galls. Though the weevil feeds on other host plants like *Capsicum* sp., *Indigofera tinctoris*, *Ipomoea nil*, *Parthenium* sp., and *Salvia* sp., breeding and gall induction has been studied only on *Phaseolus vulgaris*. Adults were active from July to November and population peak was recorded during September-October months, coinciding with the availability of host plant. Copulation lasted for about half an hour and a maximum of three larvae (Plate 1, Fig. C & D) were recorded from a single gall. Incubation period lasted for 5 to 7 days. Total number of instars observed during the study were five. Larval period lasted for 35 to 42 days and pupal period lasted for 10-12 days. Newly emerged weevil remains in the pupal chamber for 3-7 days and its color changes to become typical of the adult. Percentage infestation recorded during the period was 70%. Total life span varies from 50-60 days and atleast two generations were observed during the period under study.

KEY WORDS: Bionomics, *Alcidodes signatus*, *Phaseolus vulgaris*, Udhampur, Alcidodinae, Curculonidae, Coleoptera, India**.**

Alcidodes signatus Boheman, commonly called bean gall weevil is a serious pest of green bean (*Phaseolus vulgaris* L.), a leguminous vegetable, popular as green bean. The plant and its leaves are also used as fodder for animals. The bean vegetable contains carbohydrates, fats, proteins, water, a number of vitamins like vitamin A, pantothenic acid, many minerals like Iron, magnesium, calcium and zinc as dietary components and has high nutritive value. The weevil occurring at very early stages of the crop in the field causes serious damage to the crop. Though the weevil also feeds on alternate host plants gall induction has been recorded only in case of *Phaseolus vulgaris*. Adult remains active from first week of June to mid November in all bean growing areas of Udhampur district of Jammu region. Abrol (2006) recorded a complete failure of the crop in some locations with losses estimated to the tune of 90-95 per cent whereas Azam (2007) recorded the weevil as a serious pest of beans with 56.07% damage. Adults hide under the axil of branches or between the tender leaves and terminal portions. These make holes on the leaves and numerous punctures on the stem, leaf buds and petioles. Later, the girdled portions containing egg appear and the larvae within the stem make galleries. This results in uneven growth of the stem leading to gall formation and the plants present a sick appearance. As systematic studies on the habit, pest status, seasonal occurrence, life history and ecology of *A. signatus* are lacking, detailed investigations were conducted on green bean.

MATERIALS AND METHODS

The weevils were collected from five different sites viz. Champari, Noti, Treli, Sudmahadev and Patnitop of Udhampur district of Jammu province where bean crop is commonly grown. Studies were conducted during the period 2009-2010 when the occurrence of the weevil was at peak. Rearings were made through culture on potted cage plants. Eggs were obtained both from the field as well as in the Laboratory. The shoots containing eggs were kept in glass tubes of 10×2.5 260 cm keeping the wet cotton at the base of shoot. Entire larval period is passed inside the stem. Only the total larval period could be counted and to determine the individual larval periods newly hatched larvae and subsequent larvae of different ages were collected and subjected to Dyar's law for subsequent analysis. To determine the pupal period mature larvae collected from infested plants were observed at regular intervals till the emergence of adults. For morphological studies larvae, pupae and adults were preserved in 90% ethyl alcohol. Eggs were preserved in 5% formalin with few drops of glycerine. The mode and extent of damage caused by the adults and larvae were studied by visual observations of the symptoms of damage and counting the number of damaged plants during the breeding period of the weevil.

OBSERVATION AND DISCUSSION

Distribution

Meghalya, Shillong (Barwal, 1990), Bani (Abrol et al., 2006), Poonch & Rajouri (Azam, 2007). Udhampur: Champari, Noti, Treli, Sudmahadev and Patnitop (present studies).

Host plants

The weevil feeds on legumes, larvae form galls in the stem of *Phaseolus* species while adults found feeding on some alternate host plants when bean plantation is not fully grown or when the beans are absent or harvested. Barwal, (1990) and Abrol (2006) recorded it as a pest of *Phaseolus vulgaris* (French beans) and Azam (2007) observed the weevil feeding on *Phaseolus vulgaris*, *P. lunates*, *P. coccinus*, *Salvia* sp., *Capsicum* sp., *Indigofera tinctoris*, *Ipomoea nil* etc.

Pest status

Alcidodes signatus has been recorded as a serious pest of beans from the region under study. Both the grubs and adults damage the beans. Larvae are more destructive and damage the plant by tunneling and forming galls in the stem. The damaged plant weakens which sometimes falls with the wind. Maximum number of adults recorded from a single plant of 3 feet height were six. A maximum of 15 individuals at different stages of development were recorded from five plants during first week of October. Abrol et al. (2006) and Azam (2007) recorded the weevil as a serious pest from Poonch and Rajouri districts of Jammu region.

Seasonal occurrence

The weevil comes out of the winter rest during the first week of June and looks for alternate host plants on which they feed for some days. Breeding period varied from July to November on the host plant under study and during the rest of the year the weevil undergoes winter rest. The weevil is more active during dawn and dusk hours of the day. Azam (2007) observed the weevil to be active from June to

mid November whereas Abrol et al. (2006) observed the weevil to be active from July to September months. The weevil feeds on leaves, buds, flowers and succulent branches of the alternate host plants for 20 to 30 days, then moved to the bean field where they mature sexually, start feeding, girdling the main stem and side branches and ovi-positing the girdled portions of the stem and side branches. Population reaches peak during August-September months coinciding with the growth and development of the beans.

Nature and Symptoms of damage (Plate 4, Fig. T, U)

Infestation of the weevil in the field is indicated by the presence of damaged leaves, galls on the stem and side branches, fallen side branches and tender petioles. On close observation, the adults could be seen hiding in the leaf axils or under the leaves of the host plant. Adults make holes through the leaves and scoop the tender buds, petioles, young stem and side branches and even soft fruits. The larvae bored into the tissues of the plant and form galls. The damage caused by the larvae is more severe and extensive than the adult. The adult female after fertilization, bores the tender portions of the host plant with her snout, turns around to lay egg in the hole. Usually a single egg is laid in one hole but the same site can be used from the other side to lay the egg at a different angle. Egg hatches into a apodus larva which feeds on the internal tissues of the plant. As a result the site of injury gets swollen to form gall. The infested plant shows stunted growth and its leaves turn yellowish brown. The region at the site of gall becomes weak and the plant beyond the region of gall (whole plant or side branch depending upon whether the gall is formed on the main stem or side branch) may fall of with a strong current of the air. The weevil causes severe damage to the bean crop by forming galls in the stem and indirectly by weakning the plant that falls down with the wind. Almost similar observations were observed by Barwal (1990), Abrol et al. (2006) and Azam et al. (2007). The percentage infestation recorded during the present study was 75%. Abrol et al. (2006) recorded the weevil as a serious pest of beans with more than 95% damage in Bani (Kathua). Azam (2007) observed the weevil as a serious pest with 56.07% (mean) infestation.

Life cycle

Emergence

Beans are sown in the month of May along with maize and the emergence of the weevil coincides with the host plant (beans). For 15-25 days the weevil feeds on alternate host plants like *Capsicum* sp. *Parthenium* sp. *Indigofera* etc. already present in the field. After feeding on alternate host plants for some days the weevil moves to the bean crop. Adults were active from June to November.

Mating behaviour (Plate 3, Fig. L)

Copulation lasts for about 30 minutes during which the male succeeds in riding over the female, the later is then held firmly by the male with its legs and its antenna remain directed upward and forward. Copulation occurs in the morning and evening hours when it is cool and calm, male strikes the female with its snout and the mating pair usually hides in the leaf axils and branches. The pair usually falls to the ground with the slight disturbance and feigns death but male still holds the females firmly. Copulation usually lasts for 20 to 30 minutes but may extend for hours together during night or early morning hours.

Oviposition behavior

The adult female after mating selects a suitable spot for egg laying. Usually the soft, thick stem or side branches are selected for egg laying (Plate 3, Fig. M). Female makes a small hole with her snout at the site of egg laying whose depth depends on the length of snout. Then she turns around, inserts her ovipositor to lay a single egg in the hole. After egg laying the hole is sealed with scooped material. If another egg is to be laid then it is laid either at a different site or at a different angle at the same site. Eggs are laid usually in the main stem and sometimes in the side branches but always a few inches (never below 1.5 inches) above the ground. Again no egg was laid in the in the month of October as the plant gets hardened and dry.

Egg (Plate 1, Fig. A)

Egg elongated, cylindrical with rounded ends and yellowish white in color having smooth dorsal surface and two spine like structures on the ventral sides. It measured from 1.08 to 1.46 mm in length with an average of 1.27±0.13 and 0.48 to 0.86 mm in width with an average of 0.68±0.15 mm.

Egg period

Egg period varied from 4 to 6 days with an average of 5.06±0.84 days in the months of July-August. Egg hatches into a small, legless and creamish white larva. It starts feeding around the site of injury.

Number of Larval instars (Plate 1, Fig. B, C, D & E)

As the larvae of *Alcidodes signatus* are internal feeders and remain inside the plant tissues throughout their life so the number larval instars could not be determined. The newly hatched larvae and subsequent larvae were collected and subjected to Dyar›s law which revealed the number of instars to be five (Plate 1, Fig. E). Similar problems were encountered by earlier workers (Tara, 1983 in case of *B. rufomaculata* a borer, Singh & Rohilla, 1990 in case of *Antigastra catalaunalis*, leaf webber and Pod borer and Azam, 2007). They applied Dyar›s law to evaluate the number of larval instars. To determine the number of larval instars the present author also used Dyar›s law and results obtained are recorded below. The law states that the "width of head capsule of larva in its successive stages follows a regular geometrical progression". The law was originally based on the measurements of head widths of 28 species of Lepidoptera (Dyar's, 1890). But the law has proved its applicability in many more groups of insects. The law finds its applicability in cases where moults cannot be seen easily as in the present case. As the larvae do not show much difference, so description of first and final instars are given and the measurements of all the larvae are presented in the tabular form.

First instar

First larval instar is creamish white, legless, slightly curved, C-shaped with prominent head, smooth and shinning body, giving a yellowish tinge and a dark streak posteriorly on the frontal region. Mandibles strong, dark brown and bidentate. Segments of the body are not easily discernible and the entire body is enclothed with minute hairs.

Final instar

Fifth instar soft, apodus, creamy white, curved, C-shaped and wrinkled. Mandibles strong, dark brown with the base broader than the apex. Head capsule

smooth, dark brown and rounded. Epicranial suture less conspicuous, slightly smaller than half the cranial length. Thorax three segmented and roughly one fourth the body length with sparse setae on all the three segments. Each of the thoracic segments bears a pair of distinct pedal lobe ventrally with tuft of hair. Abdomen ten segmented with all the segments easily discernible. First eight segments are equal in size, ninth smaller and tenth segment has a rounded posterior end. Spiracles nine pairs, small, brownish, spherical and equal in size. One pair of spiracles present between prothoracic and mesothoracic segments and the remaining nine pairs are present laterally on each of the first eight abdominal segments. The larva stops feeding forms a pupal chamber and enters into pupation. The measurements of the head capsule and body length of various instars are given below.

Pupation

The full grown larva stops feeding and undergoes pupation accompanied by shortning of body length and slight swelling in the thoracic region. The larva pupates in the larval tunnel by placing frass at both ends on its either side and gets enclosed in oval shaped chambers.

Pupa (Plate 2, Fig. G & H)

Pupa measures 8.8 mm to 11.5 mm in length with an average of 10.02±1.00 mm and 4 to 4.5 mm in width with an average of 4.2±0.15 mm. Pupa exarate, naked and creamish white and turns dark before transforming into adult. At first, extremes like tip of snout, legs turn dark followed by darkning in the middle. Head smooth squarish and bears two raised outgrowths at the front end and two prominent, black eyes obliquely at the base of snout. Head produced in front into a long and well developed rostrum which bears mandibulate mouth parts at the tip. A pair of geniculate antenna arise from the middle of snout one on either lateral side. Body soft, bears minute hair which matches the body color. Prothoax rectangular, broader than long and bears raised minute setae on the tubercles. Meso and metathoracic segments are equal in width but smaller than the prothorax roughly half its length and bear minute setae in the middle. Abdomen ten segmented, segments one to eight bear two horizontal rows of setae on tubercles at both the anterior and posterior margins dorsally, penultimate segment bears a single row of setae with brownish tips on tubercles dorsally, last segment rounded posteriorly and bears a pair of dark, long, anal setae on each lateral side of transverse anus. A pair of brown, spherical and minute setae are present laterally on each segment one on each side. Pupation occurs in the pupal chamber in the gall by plugging the two ends with frass. It stays in the pupal chamber even after transformation into adult for 3 to 7 days when its color becomes exactly that of adult accompanied by hardening of body parts, becomes fully grown and comes out of the galls by encarving an exit hole.

Adult description (Plate 2, Fig. I, J & K (male and female))

Adult body stout, compact, ovoid, convex dorsally with longitudinal grey and black strips alternating with each other and running longitudinally throughout the length of elytra. In addition, three longitudinal white strips are present on the dorsal side of each elytra which remains closely applied and completely covers the abdomen. A creamy white stripe runs longitudinally from the middle of snout slightly beyond the middle of thorax. Thorax bears two oblique creamy white strips throughout its length. Head small, rounded, prologed anteriorly into a cylindrical, slightly curved snout which bears black, mandibulate mouth parts at

the tip and bears a pair of black, depressed eyes antero-laterally at the base of snout. Antenna black, geniculate, arise mid-laterally from the snout and bear brown hair throughout its length. Scape long, broadens gradually towards the tip, funicle seven segmented, club broader in the middle, three segmented. Prothorax longer than broad with anterior end narrow than the posterior. Legs three pairs with first pair longer than the other two. Coxa globular, trochanter small, femur long, stout, broader in the middle with a femoral tooth, tibia cylindrical with two tibial spines at the posterior end. Abdominal segments clearly visible on the ventral side enclothed with yellowish hairs. Adults capable of short flight, fall on the ground on slight disturbance and feign death. Body length varying from 8.5 to 10.5 mm in length with an average of 9.42 ±0.78 mm and 4 to 5 mm in width with an average of 4.48±0.08 mm. Adult feeds mostly on soft, succulent tissues of the plant.

Number of generations

Two generations were observed during the present studies from June to November. During the rest of year, the weevil undergoes winter rest in the cracks and crevices of the soil, in the stalks of the dried plants and in the stalks of other plants till the favourable conditions return again. Similar observations were recorded earlier by Azam (2007) and Barwal (1990). Both observed two generations in a year in the life history of the weevil at Poonch-Rajouri and Meghalaya. Whereas Barwal (1992) observed only one generation in the life history of the weevil in Himachal Pradesh.

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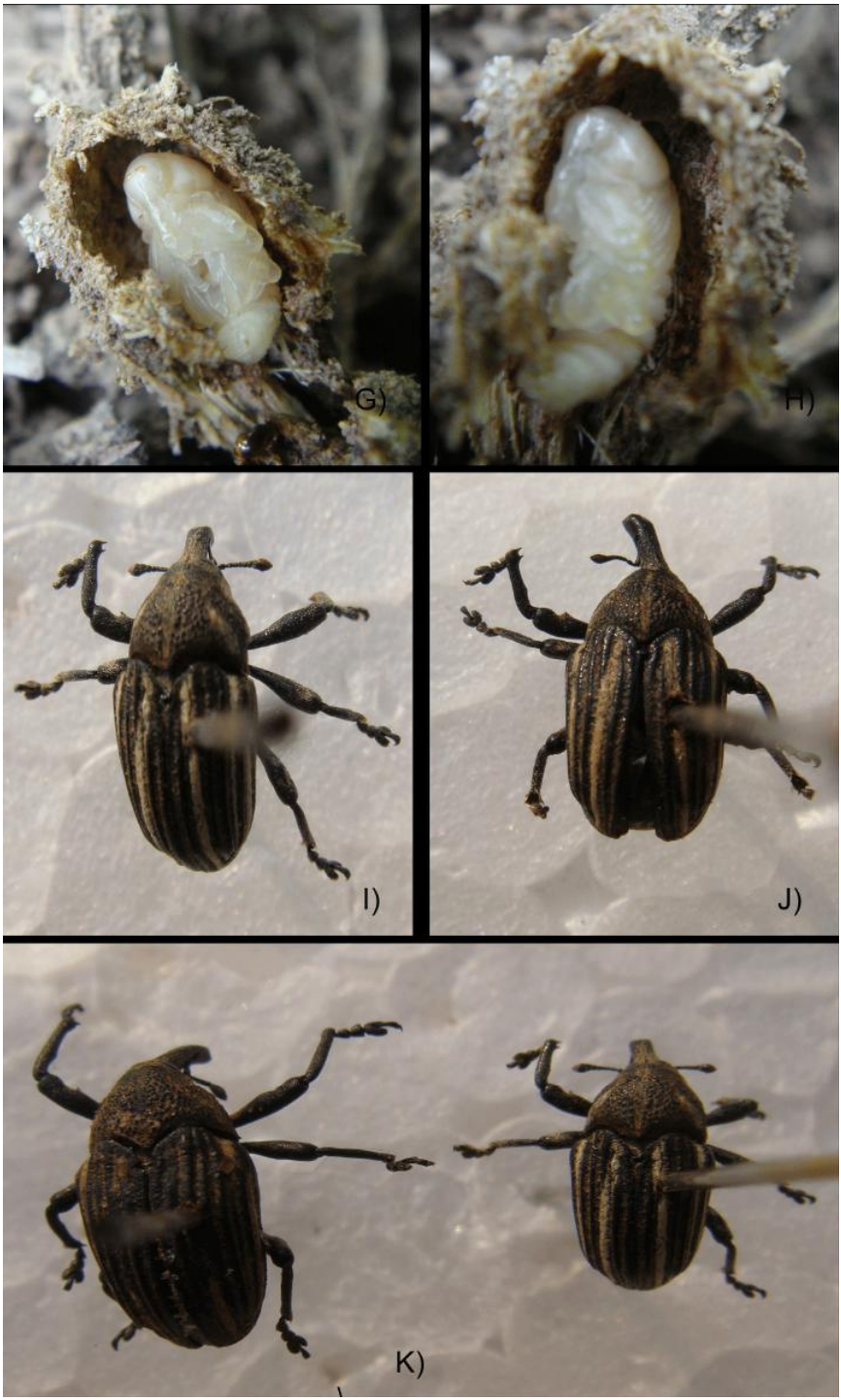
Table1. Showing measurements (in mm.) of head capsule and body length of various instars.

Stages	**Body length**			**Body width**			**Head width**		
Grubs	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean
1st	1.2	1.4	1.3±0.07	0.48	0.59	0.53±0.04	0.43	0.5	0.46±0.02
2nd	1.5	2.5	2.01±0.38	0.52	1.2	0.84±0.26	0.5	0.75	0.6±0.07
3rd	4.8	6.0	5.4±0.49	1.2	1.9	1.58±0.25	0.9	1.1	1±0.07
4th	7	8	7.54±0.38	2.0	3.0	2.58±0.4	1.2	1.6	1.4±0.15
5th	8.5	10.5	9.56±0.8	3.0	3.9	3.52±0.39	1.6	2.0	1.81±0.15


A)
B)
C)
D)
E)
F)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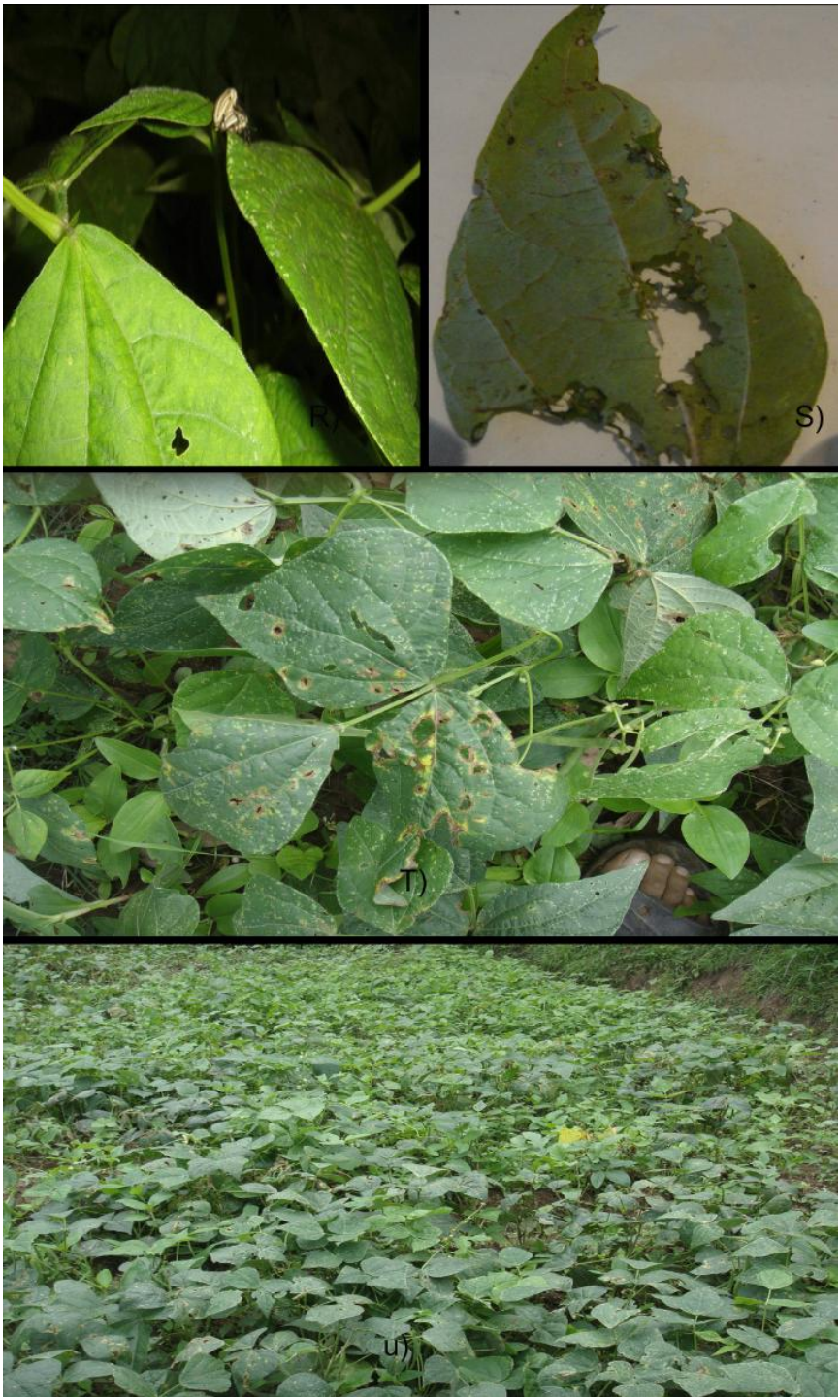
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