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Feeding Preference, Nymphal Development Time, Bodyweight Increase, and Survival Rate of the Bean Bug, *Riptortus clavatus* (Thurnberg) (Hemiptera: Alydidae), on Soybean Varieties

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ABSTRACT : The soybean varieties the bean bug preferred the least were Kwangankong, Namhaekong, Sunamkong, Sorogkong, and Anpyeongkong, and next to them was Pungsannamulkong, among 25 varieties examined. Myongjunamulkong and Eunhakong supported a good growth of the bug as the daily gains of weight of 3rd instar nymphs were 14,9 and 13.9 mg, respectively. On the other hand the bug on Punsannamulkong gained weight daily as little as 10.1 mg. On Pungsannamulkong the nymphal development of the bean bug took 24.5±2.1 days, about three days longer than those on Myunjunamulkong and Eunhakong. The survival of the bean bug on Punsannamulkong was 83%, slightly lower than those on Myunjunamulkong and Eunhakong. It seemed evident that Pungsannamulkong have a non-preference type resistance to the bean bug.

KEY WORDS : Soybean variety, Pungsannamulkong, Bean bug, R*iptortus clavatus*, Non-preference

초 록 : 톱다리개미허리노린재의 선호도가 가장 낮은 콩 품종은 시험에 이용된 25품종 중 광안콩, 남해콩, 서남콩, 소록콩, 안평콩 등 5품종이었다. 그 다음으로 선호도가 낮은 품종은 풍산나물콩 등 7품종 이었으며, 명주나물콩과 은하콩은 톱다리개미허리노린재의 선호도가 비교적 높은 품종으로 3령약충기 일일발육량이 각각 14.9 mg 과 13.9 mg으로 나타났다. 이에 반해 풍산나물콩에서는 일일발육량이 10.1 mg으로 나타났으며, 약충의 발육기간도 명주나물콩과 은하콩에 비해 3일 정도 긴 24.5±2.1일이었고, 생존율은 명주나물콩과 은하콩에 비해 약간 낮은 83%로 나타났다. 생존율과 선호성 일일발육량 등을 비교해보면 풍산나물콩은 톱다리개미허리노린재에 대해 비선호성에 따른 저항성을 갖고 있는 것으로 보인다.

검색어 : 풍산나물콩, 비선호성, 톱다리개미허리노린재, *Riptortus clavatus*

The bean bug, *Riptortus clavatus* (Thunberg) is a serious pest of many crops attacking not only soybean, but also rice, sesame, fruit trees, flowers and even medicine crops (Lee *et al.*, 2004; Kang *et al.*, 2003; Song *et al.*, 1998; Honda, 1986; Kono, 1989; Teramoto and Nagai, 1983), in particular, the damage of the bug to soybean is considered to be more serious as the bug feed preferably on pod piercing directly and sucking the bean in it. It is well known that the bug is difficult to control because of it's escaping response to insecticides. The bug tend to fly away from the field where insecticide appliedand return when the toxicity of the insecticide became ineffective. It is obvious that the use of resistant varieties is the cheapest and the most effective method of combating the pest. More often than not, however, resistant varieties give only a partial control of a pest, additional control measures must be adopted in severe infestations. Nevertheless even a partial resistance can

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be very valuable because other control measures are generally much more effective on partially resistant varieties than on susceptible varieties. Fewer insecticide application are usually needed and parasites and predators can also give a more effective control of insect pests on resistant than on susceptible varieties.

There are some hopeful reports in relation to the resistance of soybean plant against the bean bug. Park *et al.* (2004) studied the effects of purified persimmon tannin and tannic acid on survival and reproduction of the bean bug to find that persimmon tannin exerted negative effects on survival and reproduction of *R. clavatus* at higher concentrations (1 and 3% solutions). Mizutani *et al.* (2001) reported the resistance of the soybean breeding line Kyukei 279 to soybean stink bugs providing evidence that percentages of soybeans injured mainly by soybean stink bugs were significantly lower in Kyukei 279. Kuroda *et al.* (1996) observed that cysteine proteinase inhibitors in rice seeds caused growth retardation of *R. clavatus*, when added to their diets at concentration of 0.3-0.5% (w/w). Mohri *et al.* (1990) demonstrated that the products of linoleic acid oxidation by soybean seed lipoxygenases, such as linoleic acid monohydroperoxides and hexanal, had a repellent effect on the coreid *R. clavatus*. Ishimoto and Kitamura (1993) reported the inhibitory effects of adzuki bean weevil-resistant mungbean seeds on growth of the bean bug.

In this study we tried to find a solution by resorting to the resistance of soybean varieties, if any, to solve the bug problem. A total of twenty five bean varieties were examined for the feeding preference of adult bean bug to them. And the larval performance of the bug feeding on some selected varieties were compared in terms of their development time, survival and body weight increase.

Materials and Methods

Rearing experimental insect

The bean bugs were maintained in insect rearing room in a plastic cage (size, 40×40×50 cm) under the photoperiod of 16 (L): 8 (D), 25±2℃ constant temperature, and 60~70% humidity. About 200 bugs were caged together and the soybean seedling about one to two weeks old and/or dry bean (Myunjunamulkong) were used as food, and water was provided when dry bean only was used as food through a cotton plug in a test tube filled with water.

Feeding preference to and bodyweight increase on bean varieties

For the feeding preference, fifty pairs of adult were released in a cage (35×35×40 cm) in which 25 fresh bean pods, one pod from each of 25 varieties, were distributed in random order in a circle 3 cm apart from each other. The number of adults feeding on pods at the time of recording was counted every 3 hrs from 9:00 am to 6:00 pm for 3 days 15 times overall. The observations were replicated 5 times. The varieties screened includes Kwangankong, Namhaekong, Sunamkong, Sorogkong, Anpyeongkong, Dagikong, Somyeongkong, Sowonkong, Sohokong, Iksannamulkong, Pungsannamulkong, Hannamkong, Doremikong, Pureunkong, Dachaekong, Myongjunamulkong, Tawonkong, Bukwangkong, Saebyeolkong, Sobaeknamulkong, Eunhakong, Paldokong, IAC-100, A-6, and Jangannogdu.

For measuring the development time of 3rd nymphal stage and the body weight gain, a newly molted 3rd instar nymph was kept in a petridish(∅9 cm) and served 5 dry beans of each of 30 varieties and the weight was measured at the beginning of the experiment and at the time of molt to 4th instar nymph, and the time had been taken for completing the 3rd nymphal stage was recorded. The weight gained was divided by respective nymphal periods of each bug and expressed as the amount of daily growth. The data obtained from the nymph died before molting to 4th instar were discarded. Each observation was started with 10 bugs. At least five replications were made for each observations. All the varieties that were used for the feeding preference study except for the two varieties, IAC-100 and A-6, were screened.

Nymphal development time and survival rate

The varieties being screened were Myongjunamulkong, Eunhakong and Pungsannamulkong. Dry beans were provided as food and compared the stage specific development time and survival rate of nymph with those reared on the control varieties, IAC78-2318 and Jangannogdu.

In a petridish(∅9 cm), one newly hatched nymph was placed together with 10 dry beans of selective variety. Water was supplied in a plastic dispensible pipett (1 ml) plugged with a piece of spongy. The time required for completing each nymphal stage were determined by observing shedded molting skin everyday 9:00 AM, and the dead bugs were recorded as well, and 20 replications were made for each variety.

Results and Discussion

Feeding preference to and bodyweight increase on bean varieties

The bean varieties out of 25 varieties that were classified in group I include Kwangankong, Namhaekong, Sunamkong, Sorogkong, Anpyeongkong, and Jangannogdu (Table 1), and Dagikong, Somyeongkong, Sowonkong, Sohokong, Iksannamulkong, Pungsannamulkong, and Hannamkong were classified into group II. On the basis of the feeding frequency data we obtained in this study and the survival of the bean bug on the varieties in other experiment we conducted (Oh *et al.*, 2004), the varieties in group I and II can be assumed to have non-preference type resistance to the bean bug. Non-preference may be attributable to morphological, physiological or chemical factors in the host plant. Soybean varieties have species specific pods of different size, shape, and colour, and have hairs on the pods with different size, shape, and colour. Further studies estimating these characteristics in association with resistance may give clear insight on what characteristics contributes the non-preference. The varieties that the bug preferred the most were Tawonkong, Bukwangkong, Saebyeolkong, Sobaeknamulkong, Eunhakong, Paldokong, IAC-100, and A-6.

In an attempt to demonstrate small differences in the resistance of soybean varieties to the bug, the gain in weight by individual bug during the 3rd instar nymphal period while they are feeding on different soybean varieties had been checked. The daily gain of weight ranged between 6.4 mg on Dachaekong and 16.3 mg on Tawonkong (Table 2). The difference between the two extremes was 10.0 mg as big as almost 2/3 of the weight gained by the bug on Tawonkong. The daily gain of weight was not consistent with the feeding frequency data. However, the two varieties, Myongjunamulkong and Eunhakong, being examined further in the experiment on nymphal development time and survival rate because they were found to be susceptible to the bean bug in field experiment (Oh *et al.*, 2004), were the varieties that supported a good growth of the bug. The daily gains of weight of the bugs on the two varieties were 14.9 and 13.9 mg, respectively. On the other hand Pungsannamulkong was the variety found to be resistant to the bean bug in the field experiment. The bug fed on this variety gained

Table 1. Grouping of soybean varieties based on the feeding frequencies by female adult of *R. clavatus*.

Group	Frequency of feeding[1)]	Varieties
I	0	Kwangankong, Namhaekong, Sunamkong, Sorogkong, Anpyeongkong, Jangannogdu
II	1~5	Dagikong, Somyeongkong, Sowonkong, Sohokong, Iksannamulkong, Pungsannamulkong, Hannamkong
III	6~10	Doremikong, Pureunkong
IV	10~20	Dachaekong, Myongjunamulkong
V	20<	Tawonkong, Bukwangkong, Saebyeolkong, Sobaeknamulkong, Eunhakong, Paldokong, IAC-100, A-6

[1)] Total number of the bugs that was found feeding on the bean pods at the time of checking over the experiment weight as little as 10.1 mg, about 3~4 mg less than on both Myongjunamulkong and Eunhakong, indicating the variety is in some respect resistant in comparison to Myongjunamulkong and Eunhakong.

For many insects developing faster not necessarily means growing bigger or heavier. Many insects respond by developing quickly to maximize its population fitness to a nutritional imbalance and adverse environment. In this experiment the discrepancy of development time and the daily increase of body weight of the bug on some soybean varieties was observed (Table 2). It might be attributable either to the nutritional differences or to some secondary metabolites and hormonal change that was induced possibly by the bean varieties and the bug responded by speeding up the development. It is usually assumed that all plants are nutritionally adequate for insects. This may not be true in a qualitative sense, but plants differ in the proportions of nutrients, and there may be adaptation of the insect to a particular balance of nutrients (Huffaker and Rabb, 1984). The specificity of phytophagous insects to their plant hosts is largely determined by secondary plant metabolites, and these chemicals often serve directly or as precursors of hormones, and the behavior chemicals known as pheromones, allomones and kairomones (Duffey, 1980).

Nymphal development time and survival rate

The 3rd instar nymphal development periods of the bean bug on four soybean varieties and one mung-bean were shown in Table 3. The results showed that, among the three varieties examined, Pungsannamulkong was a variety the bean bug prefer the least except for the mung-bean and Jangannogdu, on both of which the development of the bean bug delayed almost 7 days to complete nymphal development than on others. Mung-bean

Table 2. Daily gain of weight of the bean bug and development period of 3rd instar nymph on soybean varieties

Variety	Daily gain of weight (mg)	Duration of 3rd instar nymph (days)
Dachaekong	6.4	4.0
Sowonkong	8.2	7.0
Doremikong	8.6	5.3
Sobaeknamulkong	8.8	7.3
Saebyeolkong	9.4	5.0
Dagikong	9.7	4.0
Pungsannamulkong	10.1	4.7
Sorokkong	10.5	4.0
Paldokong	11.0	4.0
Sohokong	11.2	4.7
Bukwangkong	11.3	4.0
Sunamkong	11.8	4.0
Hannamkong	11.9	5.0
Somyeongkong	12.0	5.2
Kwangankong	12.7	4.0
Pureunkong	12.8	5.0
Iksannamulkong	13.1	4.0
Anpyungkong	13.7	4.0
Namhaekong	13.1	4.0
Eunhakong	13.9	4.8
Myongjunamulkong	14.9	3.5
Tawonkong	16.3	3.6

* LSD (5%) for daily gain of weight: 0.778

Table 3. Nymphal development periods of *R. clavatus* on dry bean of five varieties under the photoperiod of 16 (L):8 (D), 25±2℃ constant temperature, and 60~70% humidity

Variety	Nymphal development period (days)					
	1st	2nd	3rd	4th	5th	Total[1)]
Myongjunamulkong	2.4±0.5	3.5±0.5	4.1±0.5	5.2±0.5	6.7±0.5	21.9±1.1a
Eunhakong	2.0±0.0	4.1±0.4	4.1±1.2	5.5±0.7	6.3±1.2	21.9±2.0a
Punsannamulkong	2.3±0.5	4.5±0.7	4.4±0.9	5.9±0.7	7.4±1.1	24.5±2.1b
IAC78-2318	2.7±0.5	4.1±0.6	4.0±0.6	4.9±0.5	7.3±1.4	22.9±1.9ab
Jangannogdu	2.7±0.5	5.5±1.2	5.5±0.7	5.0±2.8	13.5±3.5	31.5±6.4c

[1)] DMRT: F=10.0309, df=29, LSD(5%)=2.5

is generally known to be resistant to the bean bug (Ishimoto and Kitamura, 1993) and Jangannogdu is a mung-bean variety that show strong resistance to the bean bug. The nymphal development periods of the bean bug on Myongjunamulkong, Eunhakong and IAC78-2318 took 20.7±1.3 days, about the same as that reported by Bae *et al.*, (2004) on a soybean variety, Saealkong. However, the nymphal period we observed with Pungsannamulkong was 24.5±2.1 days about 4 days longer than it was with Saealkong (Bae *et al.*, 2004) suggesting that Punsannamulkong may possibly have a resistant trait.

The survival of the bean bug from the first instar nymph to adult was as low as 10% on mung-bean (Jangannogdu), but on the other four soybean varieties it was 83% or higher and the lowest survival was observed on Punsannamulkong among the four soybean varieties (Fig. 1). On the mung bean, most of the bug, about 70% of them, were dead before the molting to 3rd instar nymph. Interestingly on the Pungsannamulkong as well the large part of the dead bug died before molting to 3rd instar nymph. By combining this result with that obtained from the experiments on the feeding preference and the daily gain of weight, it seemed evident that Pungsannmulkong have a non-preference type resistance to the bean bug. Although there were slight differences in the survival, preference, and the duration of the bug on the soybean varieties examined, the role in overall population change of the bug over generations in soybean fields will be substantial to neglect. Many studies show that it is not always necessary or desirable for a variety to have a very high level of resistance. Incomplete or low level of resistance has often given an adequate level of control in the field, particularly when such resistance has been supported by other control measures. Moreover the accumulative effect on retarding population growth of a insect on such resistant plant in successive generations may provide additional benefits.

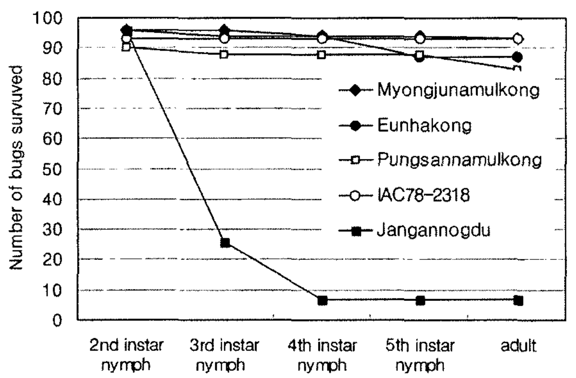

Fig. 1. Survival of *R. clavatus* from first instar nymph to adult on dry bean of five varieties. One hundred newly hatched first instar nymphs were checked for their survival to the adult.

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