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【Research report】

豆類抗蟲性的研究【研究報告】

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Abstract

摘要

豆科作物自生長收成，受各種害蟲為害，諸如豆潛蠅、葉潛蠅、浮塵子、紅蜘蛛、豆象等。 綠豆及其近親種共十六品種，種植於田間，觀察各品種對害蟲抗性的差異，發現綠豆品種﹝LM192，MS9552及LM189，9702/2﹞及米豆對豆潛蠅及葉潛蠅較具抗性。抗性品種的抗性機制是抗棲性﹝Antixenosis﹞。抗性品種的葉多毛且具較高的抗食性物質，這些因子阻礙豆潛蠅及葉潛蠅取食產卵。 菜豆對金龜子的取食具有抗性，葉的刃度與金龜子為害百分率成負相關，即葉的刃度越高者，為害率較少。 黑豆對豆象有較高的抗性，豆莢多毛，或豆之顏色可能對豆象的抗性有關。

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RESISTANCE OF BEANS TO INSECTS

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ABSTRACT

Mung bean varieties (LM 192, MS 9552, and LM 189, 9702/2) were moderate resistant to the bean fly and leaf miners. The mechanism of resistance was antixenosis. Cowpea was highly resistant to the feeding adult of the Chinese rose beetle. There is a significant negative correlation between leaf toughness and the percent area damage by the Chinese rose beetle. Among the test varieties, increase the toughness of the leaves decreased the percent area of damage by this beetle.

INTRODUCTION

Plant resistance defined by Painter (1958) as "the relative amount of heritable qualities possessed by a plant, which influence the ultimate degree of damage done by the insects." He divided the mechanism into three main categories: non-preference, antibiosis, and tolerance. Kogan and Ortman (1978) proposed the term "antixenosis" to replace the term "non-preference." This former term provides a more restrictive use of the plant and insect interaction, and also denotes the dynamic relationship between insects and plants.

Insects attack bean throughout its growth and storage. Serious among these insects are the bean fly (*Ophiomyia phaseoli* (Tryon)), leaf miners (*Liriomyia sp.*), greenhouse whitefly (*Trialeurodes vaporariorum*), Southern garden leafhopper (*Empoasca solana*), adzuki bean weevil (*Callosobruchus chinensis* (L.)), Carmine spider mite (*Tetranychus telarius*), Chinese rose beetle (*Adoretus sinicus*).

Insect population have increased so rapidly in many areas that the growing of beans is no longer possible without extensive use of insecticides. The use of insect resistant varieties is one approach to control or suppress the insect damage to beans.

In this study beans (including mung bean, rice bean, adzuki bean, black gram, cowpea and common bush bean) were planted in the Waimanalo Research Station, Hawaii between 1976 to 1978 for the study of resistance of beans to insects.

MATERIALS AND METHODS

Eleven varieties of mung bean and some related species of beans (including rice bean, adzuki bean, black gram, cowpea and common bush bean) were planted in the Waimanalo Research station, Hawaii between 1976 to 1978. Experimental design was a randomized complete block with 3 replicates of each test varieties. Fifty seeds were planted in the 4.57 m row. There was 0.91 m between rows. Each block was 2.57 m apart. Sweet corn border was planted around each block. General culture practices were followed. Methods of studying the resistance to insects disscussed as following:

(1) **Resistance to the bean fly.**

Germination counts were taken 1 week after planting. Plant stands were checked each week and mortality counts recorded.

Ten 1-month-pld plants were sampled and the percent damage and actual numbers of the bean fly larvae and puparia per plant determined by plant dissection. Leaf puncture rates were evaluated by counting the number of punctures in 20 primary leaves per replicate.

(2) **Resistance to the leaf miner.**

Malathion spraying was applied after the germination of the test varieties. Leaf samples were collected weekly and the number of larvae and puparia counted. Puparial weight was taken by using the Cahn Electrobalance Model 4400. Percent infestation of the leaf miner was recorded.

(3) **Resistance to the whitefly.**

Leaf samples were collected weekly and number of nymph and adults counted.

(4) **Resistance to the leafhopper.**

Number of nymph and adults of leafhopper counted by visual observation.

(5) **Resistance to the spider mites.**

Leaf samples were collected and number of spider mites counted.

(6) **Resistance to the cowpea weevil.**

One hundread gram of seeds of each test variety were harvested and put in the plastic cup. Percent seeds infested were measured after one month.

(7) **Resistance to Chinese rose beetle.**

Leaf feeding damage by the Chinese rose beetle was measured by sketching the leaf outline and area of damage on a typing paper. The leaf outline was weighted and then the damaged area was cut out and weight. The percent feeding area of the Chinese rose beetle was calculated by dividing the paper weight of the damaged area by the total weight of the leaf area.

The degree of resistance were used by standard deviation categorization method (AVRDC, 1975). Five categories are taken. In which one standard deviation lower the mean infestation categorized as low resistance (LR), between one and two standard deviation from the mean categorized as moderate resistance (MR), lower that two standard diviation from the mean infestation rate categorized as resistance (R). Between mean and one standard deviation categorized as susceptible (S), between one and two standard deviation categorized as highly susceptible (HS).

RESULTS AND DISCUSSION

Resistant degree of beans to insects is shown in Table 1. Among the 16 test varieties, two varieties (LM 192, MS 9552, and LM 189, 9702/2) were moderate resistant to the bean fly, and leaf miners. The mechanism of resistance was antixenosis. Resistant varieties had relatively higher degrees of pubescence. Higher amounts of antifeedant, and lower amounts of attractant compared to the

Table 1. Resistant Category of Beans to the Insects

Common bean	Variety Name	Beanfly	Leaf Miner	Chinese Beetle Ruse	White Fly	Leaf Hopper	Bean Weevil	Spider Mites
Mungbean	LM 204, MS 9724	MR	MR	LR	LR	MR	MR	S
Mungbean	LM 192, MS 9552	MR	MR	LR	LR	MR	MR	S
Mungbean	LM 189, 9702/2	LR	LR	LR	LR	MR	S	S
Mungbean	PI 377161	LR	LR	LR	LR	MR	S	S
Mungbean	PH col. 23	LR	LR	LR	LR	S	S	S
Mungbean	TH # 1	S	S	LR	LR	LR	S	S
Mungbean	M7A	S	S	HS	HS	LR	S	S
Mungbean	TN # 1	S	S	S	HS	S	S	S
Mungbean	PHCV # 18	S	S	S	HS	S	MR	S
Mungbean	TW local # 2	S	S	S	S	S	S	S
Mungbean	TW local # 3	S	S	S	HS	S	MR	S
Rice bean	HK 3	MR	R	R	LR	LR	MR	LR
Adzuki bean	TW Adzuki	HS	S	LR	LR	S	S	S
Black gram	T-9	S	LR	LR	MR	MR	R	LR
Cowpea	IVU-37	LR	S	R	MR	HS	MR	S
Bush bean	Green Crop	HS	HS	S	HS	S	MR	S

* Resistance(R), Moderate resistance(MR), Lower resistance(LR), Susceptible(S), and High susceptible(HS).

susceptible varieties. These factors prevented or deterred the feeding and/or oviposition of the bean fly and the leaf miner adults. The antifeedant chemical was an organic nitrile from cyanogenic glycoside.

Cowpea was highly resistant to the feeding adults of the Chinese rose beetle. Most of the mungbean varieties especially at the podding stage, were susceptible to this insect. Luckman (1971) stated that one fourth to one third of the foliage can be removed without great loss in yield, except during the critical pod-filling stage. Also, a 10 to 20% loss in the number of pods caused a corresponding increase in seed size and weight. Turnipseed (1972) concluded that foliage losses of 17 to 33% allowed additional light penetration to lower leaves, resulting in compensation by increased photosynthetic activity in these leaves. This demonstrated that the soybean plant had the ability to withstand considerable defoliation before yield is affected. The relationship of the damage of the Chinese rose beetles and the yield loss of mung bean should be studied. The ability of the legume to tolerate defoliation before yield is affected should be taken into account before planning any insecticides applications to prevent unnecessary spraying.

Figure 1. indicated a significant negative correlation between leaf thoughness (measured by weight required to punch disc) and the percent area damaged (with arcsin transformation) by the Chinese rose beetle.

Among the test varieties, increase in the toughness of the leaves decreased the percent area of damage by this beetle. In general, the toughness of leaves increased as the leaves grew older. Most of the damage of the Chinese rose beetle in mung bean was in the podding stage instead of the young seedling stage. In addition to the toughness of the leaves, other protective mechanisms such as biochemical factors may be involved in plant resistance to the Chinese rose beetle feeding.

Raina et al. (1978) reported a few lines of mung bean and cowpea entirely free from the Mexican bean beetle. Mung bean and black gram were ranked low in a preference scale to the Mexican bean

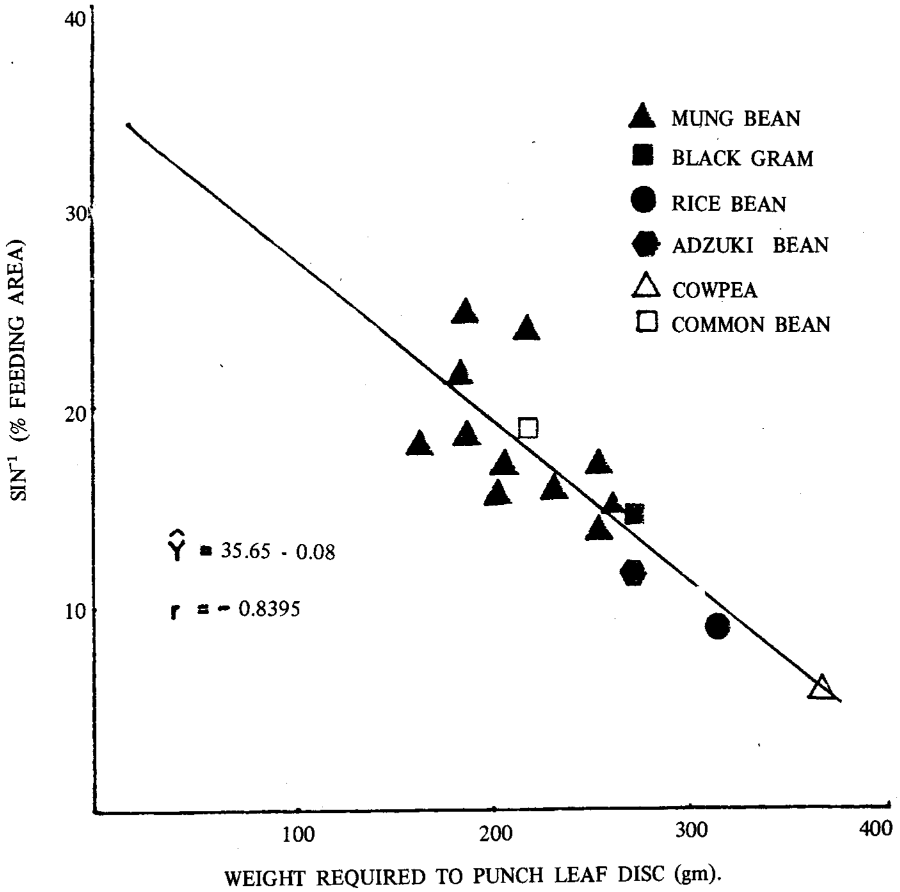

Fig. 1. Relationship between leaf toughness (measured by the weight required to punch a disc) and the percent feeding area (arcsin transformation) by the Chinese rose beetle.

beetle (Kogan, 1972a). Leaves of these plants were considerably thinner with a reduced percent moisture. The cause of resistance is probably due to the low water content of the leaf (1972b). Fractions containing phaseolunatin and/or cyanogenic glycosides were isolated from leaves of lima bean and were shown to elicit a strong biting response from the Mexican bean beetle, when present at low concentrations in combination with frucose. At the higher concentrations was responsible for the resistance of certain varietie of lima bean to the Mexican bean beetle (Nayer and Frankel, 1963).

Black gram and 4 mung bean varieties showed moderate resistance to the leafhopper. Cowpea is very susceptible to this insect. Chemical analysis of the healthy and the yellow mosaic virus infected mung bean leaves with reference to its preference by *E. kerri* was studied by Regupathy et al. (1975). They found that phosphorous, magnesium, potassium and the total content of nitrogen and sugars were less in diseased leaves, but glucoses and some different forms of nitrogen were present in higher quantitaties in diseased leaves. Calcium was required for strengthening the cell wall of the plants. The decreased in calcium might have induced plant vulnerability to stylet punctures and to the oviposition of *E. kerii*.

Black gram and cowpea show moderate resistant to the white fly. The bush bean was the most susceptible. Black gram and rice bean showed low resistance to the spider mites.

Rice bean and black gram showed resistance to the cowpea weevil. Doria and Raros (1975) observed the oviposition preference and survival of *C. chinensis* on mung bean pods of different stage of mortality. The green stage was least attractive, and the black stage was preferred for oviposition. Avidov et al. (1965) reported that ovipositional preference was determined by the seed surface area. Applebaum et al. (1970) stated that the heteropolysaccharide increased larval mortality and decreased the rate of larval development, and that arabinose and xylose affected adult fecundity. Saponin preparations inhibited development of the bean weevil and were regarded as an ancillary factor or resistance (Applebaum et al. 1969).

SUMMARY AND CONCLUSION

1. Mung bean variesties and some related species of beans (including rice bean, adzuki bean, black gram, cowpea and common bush bean) were planted in the field of Waimanalo Research station, Hawaii for studying the resistance to the bean fly, leaf miners, the Chinese rose beetle, leafhopper, whitefly, spider mite and cowpea weevil.
2. Mung bean varieties (LM 192, MS 9552, and LM 189, 9702/2) were moderate resistant to the bean fly and leaf miners. The mechanism or resistance was antixenosis. Resistant varieties had relatively higher degree of pubescence. Higher amounts of antifeedant and lower amount of attractant. These factors prevented or deterred the feeding and/or oviposition of the bean fly and the leaf miner adults.
3. Cowpea was highly resistant to the feeding adult of the Chinese rose beetle, but highly susceptible to the leafhopper. There is a significant negative correlation between leaf toughness (measured by weight required to punch disc) and the percent area damage (with arcsin transformation) by the Chinese rose beetle. Among the test varieties, increase the toughness of the leaves decreased the percent area of damage by this beetle.

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中文摘要

豆類抗蟲性的研究

林政行

豆科作物自生長至收成，受各種害蟲爲害，諸如豆潛蠅、葉潛蠅、浮塵子、紅蜘蛛、豆象等。

綠豆及其近親種共十六品種，種植於田間，觀察各品種對害蟲抗性的差異，發現綠豆品種〔LM 192，MS 9552 及 LM189，9702／2〕及米豆對豆潛蠅及葉潛蠅較具抗性。抗性品種的抗性機制是抗棲性〔Antixenosis〕。抗性品種的葉多毛且具較高的抗食性物質，這些因子阻礙豆潛蠅及葉潛蠅取食產卵。

菜豆對金龜子的取食具有抗性，葉的韌度與金龜子爲害百分率成負相關，即葉的韌度越高者，爲害率較少。

黑豆對豆象有較高的抗性，豆莢多毛，或豆之顏色可能對豆象的抗性有關。