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EVALUATION OF YARDLONG BEAN AND COWPEA FOR RESISTANCE TO *APHIS CRACCIVORA* KOCH IN SOUTHERN PART OF THAILAND

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ABSTRACT

Four F_1 hybrids were obtained between Selected – PSU (yardlong bean) as a susceptible cultivar and four cultivars of cowpea that had been reported as resistant cultivars; IT82E – 16, SR_{00} – 863, Suranaree 1, and Khao – hinson were planted in replicated plots under screenhouse conditions at the Department of Plant Science, Faculty of Technology and Community Development, Thaksin University, Phatthalung Campus Phatthalung Province, Thailand, between September and November 2009. The experimental design was a Randomized Complete Block Design (RCBD) with four replications (each replication consists of ten plots). Five apterous adult aphids were released on each plant at three weeks after planting. A number of aphids and visual scored damages were determined for each generation. Moreover, collected samples compared with stem structures. The results showed that the highest number of aphids infestation were found on Selected – PSU cultivar about 6535.02±993.56 aphids/plant. The lowest number of aphids was recorded on IT82E – 16 cultivar about 1606.81±215.34 aphids/plant. The same results were obtained from visual scored damages. When comparing cell structure, Selected – PSU cultivar gave the thinnest epidermis and collenchyma. Whereas, IT82E – 16 cultivar gave the thickest epidermis and collenchyma.

Key words: aphid (*Aphis craccivora* Koch), resistant, susceptible, cultivar.

INTRODUCTION

Yardlong bean (*Vigna sesquipedalis* L.) is a common vegetable in Asian markets. It originated from West Africa. It is cultivated extensively in many countries in Southeast Asia such as Malaysia, Philippines, Indonesia and Thailand (Tindall, 1983). This crop is also widely grown in Southern China, India and Pakistan. Thailand production area of yardlong bean was estimated at 18,560 – 20,160 ha annually (Sarutayophat *et al*., 2007). In Thailand, a major problem for yardlong bean and cowpea production is the severe infestation and damage by various insect pests in the field (Benchasri and Bairaman, 2010). Cowpea aphid (*Aphis craccivora* Koch.) is considered to be the most important pest of yardlong bean and cowpea (Sarutayophat *et al*., 2007). The damage to yardlong bean by *A. craccivora* is caused by both adults and nymphs (Ofuya, 1997). The aphid feeds by sucking fluid from the stem terminal shoots, petioles, flowers and pods (Asiwe *et al*., 2005). Heavy feeding can kill young plants, otherwise it causes stunting, distortion of leaves, delay an initiation of flowers and reduces pod set in plants which survive attack (Jackai and Daoust, 1986; Ofuya, 1993). Most damaging effect of *A. craccivora* may be through transmission of cowpea aphid – borne mosaic virus resulting in yield loss (Konate and Neya, 1996; Bashir *et al*., 2002; Laamari *et al*., 2008). Foliar application of several insecticides have been reported to be effective against *A. craccivora*. However, insecticide application is not considered to be environmentally friendly farming method. Moreover, it is harmful to human and increasing in costs of production. Reducing chemical application, resistant varieties should be more improved (Memon *et al*., 2004). Therefore, the purpose of this study was to evaluate cowpea yardlong bean and F_1 hybrids, in order to find other sources that have resistant factors, which can be transferred towards new varieties.

MATERIALS AND METHODS

Four resistant cultivars of cowpea; IT82E – 16, SR_{00} – 863, Khao – hinson and Suranaree – 1 were crossed as males with the susceptible yardlong bean (Selected – PSU) to produce F_1 hybrids (Table 1). Four F_1 hybrids and their parents were grown under the screenhouse conditions at the Department of Plant Science, Faculty of Technology and Community Development, Thaksin University, Phatthalung Campus, Phatthalung Province Thailand, between September and November 2009. The experimental design was a Randomized Complete Block Design (RCBD) with 4 replications, each replication consisting of 10 plots. Five apterous adult aphids were released on each plant at 3 weeks after planting (Annan *et al*., 1995). The conventional agronomic practices were followed to keep

the crop in good condition. The actual number of aphids/plant during weeks 4 to 7 was counted and visual damage were assessed for each generation. The visual damage was scored and based on the following scale (Wongkobrat, 1987; Benchasri, 2009)

0 = visual damage on leaves and flower buds < 10 %
1 = visual damage on leaves and flower buds 10 – 25 %
2 = visual damage on leaves and flower buds 26 – 50 %
3 = visual damage on leaves and flower buds 51 – 75 %
4 = visual damage on leaves and flower buds 76 – 100 %

Moreover, collected samples were sectioned to study epidermis, collenchyma and chlorenchyma by Poornima *et al.* (2009) method.

Table 1. Sources of seeds testing

Cultivars	Sources	Characters
Selected – PSU	Songkhla Province	Susceptible cultivar
IT82E – 16	Field Crops R.C.	Resistant cultivar
SR_{00} – 863	TVRC	Resistant cultivar
Khao – hinson	Chacherng suel Province	Resistant cultivar
Suranaree 1	Field Crops R.C.	Resistant cultivar

RESULTS AND DISCUSSION

After releasing aphids and evaluating the number of aphids between the breed of the parents and 4 pairs of F_1 hybrids in the screenhouse, it was found that the number of aphids had increased in all groups of population and was statistically significant 4 -7 weeks after planting. Four weeks of planting, it was found that there was the smallest number of aphids in IT82E – 16 cultivar which were 50.41±8.24 aphids/plant. Next was F_1 hybrids between Selected – PSU x IT82E – 16 cross, whereas the Selected – PSU cultivar was the most susceptible to aphids which was 199.29±5.12 aphids/plant. 5 and 6 weeks after releasing the aphids it was found that the number of aphids were statistically significant as regards the resistant cultivar and all the 4 pairs of hybrids. Especially 6 weeks after germinating, there were the highest number of aphids in Selected – PSU cultivar which were 4,421.02±648.12 aphids/plant. IT82E-16 cultivar resisted aphids having the smallest number of aphids which were only 1,418.02±158.14 aphids/plant. Next was F_1 hybrids between selected – PSU x IT82E – 16 corss, SR_{00} – 863 cultivar and Khao – hinson cultivar which had the number of aphids at 1,665.22±209.32 2,669.15±256.49 and 2,878.80±268.44 aphids/plant respectively. As for other groups of population, there were numbers of aphids between 2,918.24±276.56 and 3,005.24±297.78 aphids/plant (Table 2) and 7 weeks of planting, it was statistically significant between resistant and susceptible cultivars. This experiment is consistent in the report of Salifu *et al.* (1988b) which studied the resistance of bean flower thrips (*Megalurothrips sjostedti*) in cowpea in Nigeria. It was found that the number of thrips had increased rapidly and it was statistically significant between susceptible and resistant cultivars of thrips. As for the resistance to aphid in cowpea in India, it was found that it yielded similarly. The resistant cowpea had the number of aphids/plant and the weight per 10 aphids less than susceptible cultivar. Besides, it was found that aphids in resistant cowpea had formed in smaller groups than in susceptible cowpea. (Jayappa and Lingappa,1988a; Ofuya, 1989)

Table 2. Number of aphids on yardlong bean, cowpea and their F_1 hybrids between 4 and 7 weeks after planting

Cultivars	weeks after planting (Mean ± SE)			
	4 weeks	5 weeks	6 weeks	7 weeks
Selected – PSU	199.29 ± 5.12	1,456.0 ± 243.61	4,421.02 ± 648.12	6,535.02 ± 993.56
IT82E – 16	50.41± 8.24	247.82 ± 68.45	1,418.02 ± 158.14	1,606.81± 215.34
SR_{00} – 863	103.33 ± 10.35	734.61 ± 105.41	2,669.15 ± 256.49	2,998.84 ± 321.48
Khao – hinson	148.34 ± 11.87	747.33 ± 136.43	2,878.80 ± 268.44	3,001.25 ± 335.46
Suranaree 1	154.71 ± 12.78	787.73 ± 152.14	2,918.24 ± 276.56	3,021.30 ± 346.86
F_1(Selected – PSU x IT82E – 16)	77.62 ± 9.31	536.57 ± 89.13	1,665.22 ± 209.32	1,959.73 ± 289.45
F_1(Selected – PSU x SR00 – 863)	106.01 ± 13.53	785.84 ± 115.42	2,954.60 ± 267.51	3,034.07± 349.52
F_1(Selected – PSU x Khao–hinson)	165.65 ± 14.51	801.12 ± 145.25	2,991.29 ± 281.74	3,045.57 ± 353.15
F_1(Selected – PSU x Suranaree 1)	168.08 ± 14.13	814.07 ± 153.53	3,005.24 ± 297.78	3,140.05 ± 361.62
F – test	**	**	**	**
$LSD_{0.01}$	10.45	403.61	1,009.82	1,694.27
CV. (%)	10.18	12.96	14.14	16.73

** Showed significantly different between generations by Least Significant Different (LSD) test, p = 0.01

Four weeks after planting, it was found that selected-PSU cultivar had the highest intensive level of destruction which was 1.44±0.14 points, while cowpea cultivar IT82E – 16 had the lowest intensive level of destruction at 0.09±0.01 points. Next was F_1 hybrids between Selected – PSU x IT82E – 16 cross which had

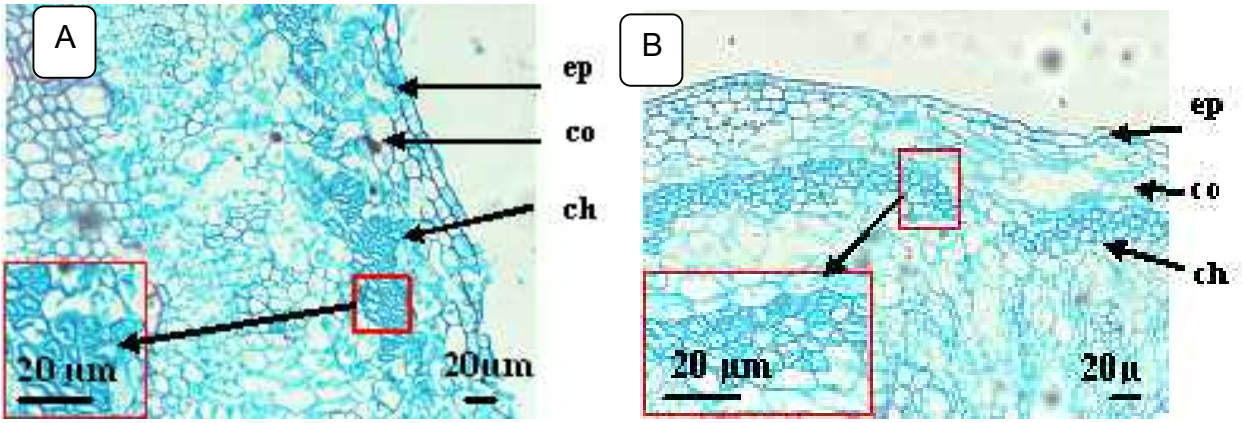
intensive level of destroying of aphid at 0.27±0.01 points. 5 and 6 weeks after releasing aphid, it was found that Selected – PSU cultivar had the highest intensive level of destroying at 3.05±0.34 and 3.41±0.45 points respectively; whereas, cultivar IT82E – 16 cultivar which resisted the aphids had intensive level of destroying of aphids at 1.20±0.05 and 1.61± 0.11 points respectively. 7 weeks after planning, it was found that Selected – PSU cultivar had intensity level of destroying of aphids at 4.00±0.00 points (maximum points). As for the population from other groups, the average was from 1.67±0.17 – 2.58±0.30 points which all of 4 parental cultivars and all pairs of hybrid had intensity destroyed level of aphid less than Selected – PSU cultivar (Table 3). The increase of destructive level of aphids was consistent in the increase of aphids in Selected – PSU cultivar which had destruction level of aphid higher than parental cultivars and F_1 hybrids of every pair of hybrid. As a result, the evaluation of the resistance of aphid can be predicted from the number of aphid or the destructive level of aphid. (Jayappa and Lingappa, 1988b; Smith, 1994).

After sectioning bean transversely and recording, there were studies the stem structure of parental cultivars and F_1 hybrids in every group of population at 6 weeks after planting which was a suitable period for studying stem structure. It was found that Selected – PSU cultivar was susceptible to aphids, having thin epidermis cell wall and collenchyma and had small-sized and a few number of epidermis which was unable to resist the destruction of aphids (Figure 1AB). On the contrary, IT82E – 16 cultivar had thick epidermis cell wall and collenchyma and as for collenchyma, it was found that the size was big with a large number (Figure 1C). As for Khao – hinson and suranaree 1 cultivars, they were found that their epidermis, cell wall were thick, but the collenchyma were thin. (Figure 1EF).

Table 3. Visual damage scored on yardlong bean, cowpea and their F_1 hybrids between 4 and 7 weeks after planting

Cultivars	weeks after planting (Mean ± SE)			
	4 weeks	5 weeks	6 weeks	7 weeks
Selected – PSU	1.44 ± 0.14	3.05 ± 0.34	3.41 ± 0.45	4.00 ± 0.00
IT82E – 16	0.09 ± 0.01	1.20 ± 0.05	1.61 ± 0.11	1.67 ± 0.17
SR_{00} – 863	0.43 ± 0.03	1.78 ± 0.11	1.92 ± 0.22	2.03 ± 0.26
Khao – hinson	0.54 ± 0.04	1.96 ± 0.12	1.94 ± 0.23	2.44 ± 0.30
Suranaree 1	0.59 ± 0.13	1.98 ± 0.18	1.96 ± 0.24	2.57 ± 0.30
F_1(Selected-PSU x IT82E – 16)	0.27 ± 0.01	1.50 ± 0.10	1.85 ± 0.16	1.72 ± 0.19
F_1(Selected-PSU x SR_{00} – 863)	0.53 ± 0.05	1.79 ± 0.12	2.13 ± 0.20	2.23 ± 0.30
F_1(Selected-PSU x Khao-hinson)	0.55 ±0.05	1.97 ± 0.16	2.20 ± 0.26	2.56 ± 0.30
F_1(Selected-PSU x Suranaree 1)	0.60 ± 0.14	1.99 ± 0.20	2.33 ± 0.28	2.58 ± 0.30
F – test	**	**	**	**
$LSD_{0.01}$	0.58	0.75	0.68	0.92
CV. (%)	5.21	7.91	9.04	10.57

** Showed significantly different between generations by Least Significant Different (LSD) test, p = 0.01



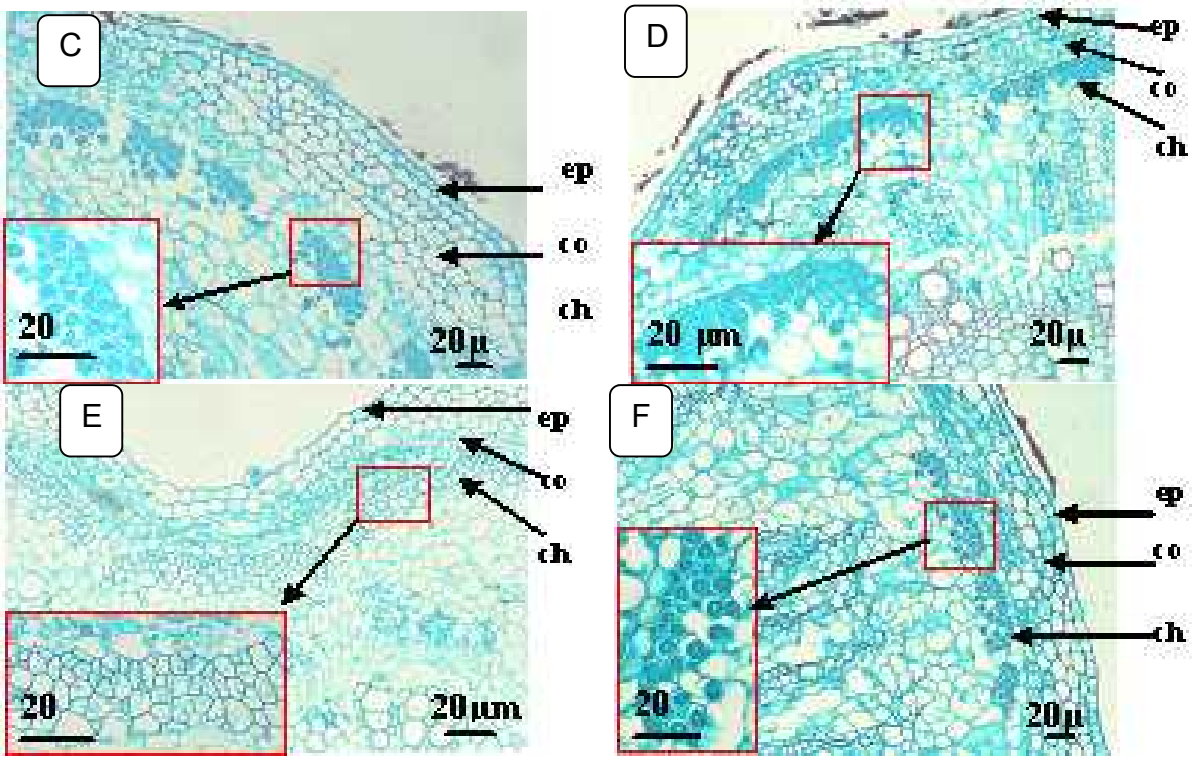
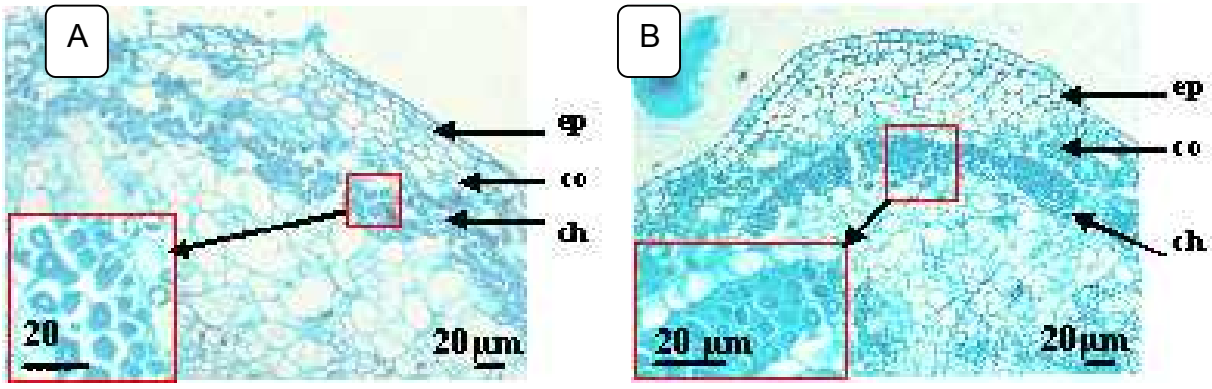


Figure 1. Physical characteristic of cell wall on parents Ep = epidermis, Co= collenchyma and Ch= chlorenchyma on yardlong bean and cowpea at 6 weeks after planting (40x)

A. Selected – PSU under natural planting ; B. Selected – PSU under screen house condition; C. IT82E – 16; D. SR_{00} – 863; E. Khao – hinson; F. Suranaree 1.

All 4 F_1 hybrids had a different epidermis of the cell wall and a number of collenchyma. However, it was found that F_1 hybrids in all 4 pairs had thicker cell wall and thicker collenchyma than the selected – PSU cultivar. Especially, F_1 hybrids between Selected – PSU x IT82E – 16 cross, had cell wall and collenchyma similar to IT82E – 16 which was able to resist aphid better than the Selected – PSU cultivar, which was susceptible to aphids (Figure 2). The experimental, result is consistent with the comparison of cell wall between susceptible and bean flower thrips resistant cultivar in Nigeria. The intensity of destroying of aphid in susceptible cultivar had thinner cell wall than resistant cultivar. (Salifu *et al*., 1988a) As a result, cell wall had an effect on the favor and un-favor of eating nutriment of aphid which caused an increase in the number of aphids and the difference in the level of intensity (Benchasri, 2009). The possibly physiological explanation could be any, or a combination of the following: presence of toxic metabolites, absence or sub-optimal amounts of essential nutrients available to the insects, presence of enzymes in the plants that inhibit normal processes of digestion of food and consequent utilization of nutrients by the insects (Saxena,1985; Alabi *et al*., 2004).



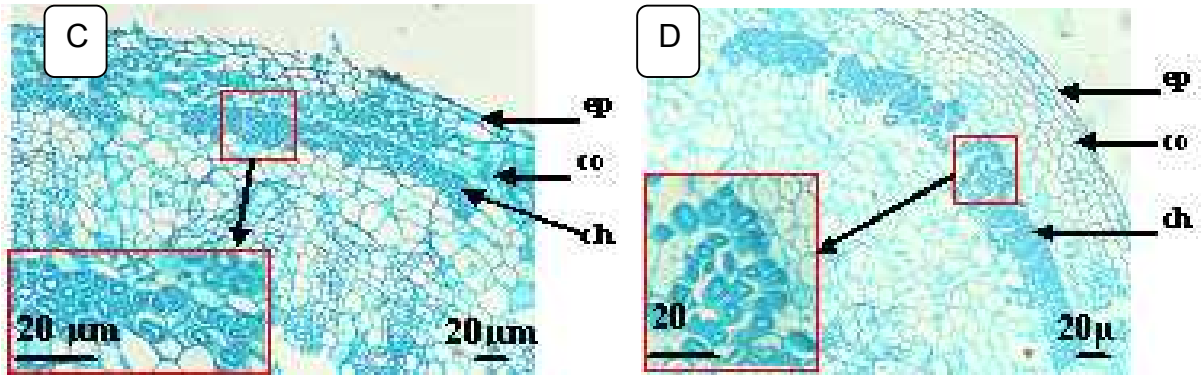


Figure 2. Physical characteristic of cell wall on hybrids, Ep = epidermis, Co= collenchyma and Ch= chlorenchyma (40x)

A. F_1 (Selected – PSU x IT82E – 16); B. F_1 (Selected – PSU x SR_{00} – 863); C. F_1 (Selected – PSU x Khao – hinson) D. F_1 (Selected – PSU x Suranaree 1).

Conclusion: When comparison of the number of aphid destroying parental cultivars and all F_1 hybrids in screenhouse conditions, it was found that the number of aphids increased in every group of generation, especially in Selected – PSU cultivar which was susceptible to aphids. There was a highest number of aphids/plant every week which was consistent with the destroying level of aphid which Selected – PSU cultivar has the highest value. Especially, after planting for 7 weeks, it was found that the points of destroying level of aphid in Selected – PSU were 4.00±0.00 points, while resistant cultivar and F_1 hybrids in every pair had destroying level of aphid less than Selected – PSU cultivar. When studying stem structure, it was found that Selected – PSU cultivar had the thinnest epidermis and collenchyma.

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