I. INTRODUCTION

Faba bean is the most important legume crop for human and livestock in Egypt. It makes an important contribution to the diet of people in many countries It represents a very interesting class of food crops due to its high protein content (30%). It can grow successfully in different soil types and it increases soil fertility. The annual cultivated area with faba bean in Egypt is about 240, 854 feddans (feddan = 4200 m^2) in 2004*. The seed yield average was 1372 kg per feddan. Many factors affect faba bean productivity. Fertilization with the essential macronutrients is the short way for increasing faba bean yield. Up till now the nitrogen fertilization of faba bean depends on biological nitrogen fixation. It is generally known that N_2 fixation by Rhizobium is enhanced in host plants well supplied with phosphate. Phosphorus is one of the major essential elements in plant life. It plays a great role in energy storage and transfer. Energy obtained from photosynthesis and metabolism of carbohydrates is stored in phosphate compounds for subsequent use in growth and productive processes. Egypt lies in the semiarid regions which affect soil characters, like soil pH. Increased pH values of the Egyptian soils affect phosphorus availability. Many investigators studied the effect of soil conditions and found that sulphur affects phosphorus availability for crops and some bio-fertilizers like microhizal and phosphorus solubilizing bacteria can be used in supplying faba bean with phosphorus. Sowing dates affect faba bean productivity due to differences in growth periods. Moreover, the stored seeds are also heavily attacked in storage by

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*Agric. Statists., Part I, Winter Crops, Dec., 2004.

several insects of family *Bruchidae*. The major pests of this family are *Bruchus rufimanus* F. and *Callosobruchus maculatus*, the larvae of *Callosobruchus maculatus* is the serious insect stage where they cause a great reduction in seed weight, germination potential and commercial value. Bruchids are a major threat to stored legume grains in West and Central Africa, and infestations by the most prominent species, *Acantghthoscelides obtectus* (Say) on common beans (*Phaseolus vulgaris* L.) and *Callosobruchus maculates* (F) on cowpea *Vigna unguiculata* (Walpers) are responsible for grain losses estimated at 20-60%. Studies of crop resistance to insect pests are very important.

The objectives of the present study are to investigate the effect of three sowing dates, two rates of mineral phosphorus fertilizer, two rates of biophosphorus fertilizer and their interactions on faba bean yield, yield components. Also, post harvest quality and the infestation potential of *Callosobruchus maculatus* on faba bean seed as laboratory determination, were studied.

II. REVIEW OF LITERATURE

I. Effect of planting date on growth characters of faba bean:

El-Murabaa *et al.* (1987 a) studied the effect of planting date on growth, yield and quality of faba bean in Assiut during 3 seasons. They found that late planting (November, 25) lessened number of days to flowering, days to fresh harvest and to ripeness. Late planting suppressed vegetative growth, as measured by plant height and number of primary branches per plant.

Amer *et al.* (1992) studied the effect of planting date (Nov. 1st, 15th and 30th) on faba bean cultivars Giza 4 and Reina Blanka and found that early planting produced higher number of branches/plant, while delaying planting date gave lower number of branches.

Bakheit *et al.* (2001) planted faba bean on 1st Oct., 20th Oct. and 10th Nov. and found that dry weight of branches reduced when planting date was delayed. They added that early planting on Oct. 1st produced the lowest number of branches/plant and the tallest plants.

Shaker (2001) studied the effect of 3 sowing dates (1st, 15th and 30th of Sept.) under Beni Swif Governorate conditions on two common beans cvs. namely Narina and Bronco. He found that planting cv. Norina on 15th Sept. and Bronco on 1st or 15th Sept. significantly increased plant height, number of branches/plant and different growth characters.

Mekky *et al.* (2003) evaluated the effects of 3 planting dates (1st, 15th and 30th Nov.) on Giza 429 and Yousef El-Sedeak faba bean cultivars. They found that the tallest plants were produced with 1st Nov. planting date. Whereas number of branches/plant was greater with 15th and 30th Nov. planting dates.

II. Effect of planting date on yield and its components:

Seed yield is the most important product of faba been plants. It was reported that the optimum planting date for faba bean cultivar Giza I was Nov. 1st in lower Egypt and delaying planting until Nov. 15th is recommended for North Delta to reduce the infection with foliar diseases prevailing in this region (**Hakam and Ibrahim, 1973)**.

Mohamed (1985), in Sudan, studied the effect of sowing dates (10th Oct. and 1st Nov.) on seed yield of faba bean (cv. BF 2/2) and found that sowing on Oct. 10 resulted in lower yield.

Amer (1986), in Egypt, studied the effect of planting date on faba bean cultivars in two seasons. He used three planting dates: early (October 15), medium (November 7) and late (November 28). The results indicated that the medium planting date gave the highest seed yield per feddan.

In field trials at Winnipeg (Canada) on faba bean cvs. Aladin, Herz Freya and Outlook which were sown on 25th April, 9th May and 23rd May, it was found that sowing dates significantly affected the yield. The early sowing date gave the highest seed yield (**McVetty *et al.,* 1986**). Also, number of pods per plant 100-seed weight, seed and total dry matter yields/plant were highest in early planting.

El-Murabaa ***et al.*** **(1987**a**)** found that late planting (November, 25) caused reduction in green pod length, number of green seeds per pod. The intermediate planting date (October, 25) gave the highest numbers of dry pods and seeds per plant, the heaviest dry seeds and consequently the highest total yield of dry seeds. Late planting sharply decreased seed yield and its contributing characters. Early planting (September, 25) was less effective in this respect. Also, percent protein in dry seeds was depressed by the earliest planting date as compared to the two late dates.

EL-Murabaa ***et al.*** **(1987**b**)** found a significant interaction between cultivars and sowing date on the yield of faba bean. They also reported that number of pods per plant had positive correlation with number of dry seeds per plant and total seed yield. Also, 100-seed weight was positively correlated with total seed yield per plant.

Noemen (1989) compared three sowing dates (10^{th} Oct., 30^{th} Oct. and 20^{th} Nov.) for two faba bean varieties (Giza 2 and Giza 402) and found that both cultivars produced higher seed and straw yields with planting on Oct. 30^{th} compared with the other two dates.

Amer ***et al.*** **(1992)** found that early sowing date (Nov. 1^{st}) produced the highest faba bean seed yield. Sowing on Nov. 30 significantly decreased seed yield of Giza 3, Giza 461 and Reina Blanka cultivars. Also, early sowing (Nov. 1^{st}) produced the highest seed yield per plant and late sowing (Nov. 30) significantly decreased number of pods/plant. They also reported that 100-seed weight, and seed yield/plant were highest with early sowing.

Sliman (1993), in Saudi Arabia, compared four planting dates (15th Oct., 30th Oct., 15th Nov. and 1st Dec.) for growing faba bean cultivars (Giza 3 and X 77TA 66). He reported that early planting produced significantly higher seed yield. Delaying seeding resulted in a 62-64% decrease in seed yield. He added that harvest index significantly decreased due to late planting.

Adisarwanto and Knight (1997), in South Australia grew faba bean (cultivar Fiord) at 3 weeks intervals between 24 April and 26 June and found that late sowing date had little effect on number of days to appearance of the first pod. With the late sowing date seed yield was increased, but the increase was not that great. They concluded that the variation in yield was largely determined by variation in number of pods per unit area. Harvest index was affected by later sowing.

Amer *et al.* (1997) reported that early sowing date (first week of Nov.) was superior to late date (last week of Nov.) in regard to seed yield of faba bean. All varieties tested produced higher seed yield in early sowing with significant differences in the second season.

Bakheit *et al.* (2001) studied the effect of sowing date (Oct. 1st, Oct. 20th and Nov. 10th) on yield and its components of faba bean cultivars (Giza 402, Giza 2, Giza 429 and Giza 674) in new and old soils. They found that early planting produced the highest straw yield and seed index, while the highest seed yields (14.15 and 12.13 ardab/fed) were obtained from Giza 429 sown on Oct. 20th, in two locations. They added that number of pods/plant was not affected by cultivars in newly reclaimed soil and the highest seed index was obtained by Giza 429 and 674 in both locations.

Shaker (2001) studied the effect of 3 sowing dates (1^{st}, 15^{th} and 30^{th} of Sept.) on growth and yield of two common bean cvs. namely Narina and Bronco. He found that the highest seed yields were produced by Narina-planted on 15^{th} Sept. and Bronco planted on 1^{st} and 15^{th} Sept. He added that early sowing significantly increased growth characters, and 1000-seed weight (g).

Abuldahab *et al.* (2002) investigated the response of faba bean to sowing date (10^{th} Oct. (early), 10^{th} Nov. (mid) and 10^{th} Dec. (late). The results showed that number of days for emergence and flowering bud were increased as sowing date was delayed. Number of days for first flower 50% flowering and last faded were reduced as sowing was delayed. Late sowing date consumed the highest total sunshine hours at stages of emergence flowering bud, 50% flowering and last faded. The highest seed and straw yields were obtained with Nov. sowing date when compared with the other planting dates. Also, the greatest number of pods/one m^2 and seed yield/plant were produced in Nov. planting.

Mekky *et al.* (2003) evaluated 3 sowing dates (1^{st}, 15^{th} and 30^{th} Nov.) for 2 faba been cultivars Giza 429 and Yousef El-Sedeak). They found that sowing on Nov. 30^{th} produced the highest number of pods, weight of pods and weight of seeds/plant, greatest seed dry weight and seed yield/fed, whereas early sowing on 1^{st} Nov. produced the lowest values.

III. Effect of bio-phosphorus fertilization on faba bean growth characters:

Arafat *et al.* (1995) reported that inoculation with Rhizobium or Vesicular-Arbuscular Mycorrhizal (VAM) significantly increased dry shoots weight of faba bean.

Abo El-Nour *et al.* (1996) found that application of "phosphorien" (a biofertilizer) significantly reduced dry shoot weight pr plant in faba bean compared with the application of the recommended phosphorus dose.

Reda *et al.* (1996) showed that the application of biofertilizers to faba bean plants produced the greatest dry weight of branches and leaves/plant. Inoculation was done by Rhizobium bacteria and VA mycorrhizae. Inoculation of chickpea seeds with microbien associated with mineral phosphate fertilizer significantly increased plant height (**Bahr, 1997**).

Biofertilization of soybean plants with microbien increased plant height (**Abdel-Wahab *et al.*, 1999**).

El-Kalla *et al.* (1999) found that application of phoshorien significantly increased number of branches/plant and plant height of faba bean.

Hamissa *et al.* (2000) found that the application of phosphate solubilizing bacteria (phosphorien) significantly increased plant top dry weight of faba bean.

Saleh *et al.* (2000) showed that inoculation of rhizobium to faba bean in old land resulted in a significant increase in dry shoot per plant.

Abdalla (2002) showed that application of the biofertilizer (phosphorien) to faba bean plants increased plant height.

IV. Effect of bio-phosphorus fertilization on faba bean yield and its components:

Hussein *et al.* (1991) studied the effect of biofertilizer application (as bacterial inoculation) on faba bean and reported that seed yield was increased by 1.48 tons per hectare (39.8%) due to biofertilization. Also, straw yield increased by 3.14 tons/hectare (44.9%).

El-Awag *et al.* (1993) reported that phosphobacterin caused significant increase in soybean seed and straw yields as compared with the control treatment.

Hussein *et al.* (1997) found that application of 37 kg P_2O_5/ha as mono superphosphate (15% P_2O_5), 60 kg K_2O/ha and inoculation with Rhizobium as biofertilization significantly increased faba bean seed yield by 2.23 tons/ha, straw yield was also increased.

Bahr (1997)showed that inoculation of chickpea seeds with microbien containing phosphorus solubilizer associated with mineral phosphate fertilizer significantly increased seed and straw yields/fed Also, number of pods/plant and 100-seed weight were increased.

Abdel-Wahab *et al.* (1999) reported that biofertilization of soybean plants with microbien containing phosphate solubilizer increased seed and straw yields/fed Also, number of pods/plant, 100-seed weight and seed yield/plant were increased.

El-Kalla *et al.* (1999) found that application of biophosphate fertilizer (phosphorien) resulted in an increase in number of pods/plant, 100-seed weight, seed yield/plant, plant height and seed yield/fed The results indicated that highest P rate (45 kg P_2O_5/fed) and phosphorien increased seed protein percentage, of faba bean.

Hamissa *et al.* (2000) mentioned that application of phosphate solubilizing bacteria (phosphorien) significantly increased top dry weight/plant and seed yield/fed of faba bean.

Saleh *et al.* (2000) conducted field trials in old land and sandy soil on faba bean which was inoculated with Rhizobium as biofertilizer. They found that in the old land, inoculation of faba bean with biofertilizer gave significant increase in seed yield. In the sandy soil inoculation increased seed yield by 0.067 ton/ha (13.6%) compared with the check.

Yakout *et al.* (2001) found that application of biofertilizer (microbien) to faba bean significantly increased seed yield.

Zeidan *et al.* (2001) found that when faba bean plants (cvs. Giza 2 and Reina Blanka) were treated with biofertilizer (microbien) and organic fertilizer, number of pods/plant, seed yield/plant, and seed and straw yields/fed were significantly increased. Seed yield/fed for Giza 2 and Reina Blanka was 2.55 and 3.08 tons, respectively.

Abdalla (2002) showed that treating faba bean plants with biofertilizer (phosphorien) markedly increased number of pods/plant and seed yield. The cultivar growth in the trial was El-Kobrosy.

Ahmed *et al.* (2003) studied the effect of a biofertilizer (phosphorien), chemical fertilizers (NPK) and organic manure on the growth and yield of faba bean cv. Giza 614. The results showed positive effects of applied treatments compared with the control particularly on seed and straw yields/fed They found also that 100-seed weight, seed yield/plant and seed protein yield were the highest with application of both bio and mineral phosphorus fertilizers.

Knany *et al.* (2004) concluded that inoculating faba bean seeds by P dissolving bacteria significantly increased seed yield as well as P in the soil.

V. Effect of mineral phosphorus fertilization on faba bean growth characters:

Salem and El-Massri (1986) in field trials on faba bean cv. Giza 2 which was supplied with 0, 35.5, 71.43 and 107.14 kg P_2O_5/ha, found that 107.14 kg P_2O_5/ha significantly increased plant height, number of branches/plant and shoot dry weight/plant.

Salem and El-Nakhlawy (1987) found that application of 35.5 kg P_2O_5/ha significantly increased number of branches/plant in field bean.

Gomaa (1991) found that faba bean cv. Giza 2 receiving 30 kg P_2O_5/fed significantly increased dry weight/plant.

Radwan (1992) found that application of 60 kg P_2O_5/ha to faba bean cv. Giza 3 increased number of pods plant, plant height and dry weight/plant.

Hassanien (1995) reported that the application of 15.5, 31.0 and 45.5 kg P_2O_5/fed markedly increased growth characters of Giza 2, Giza 3 and Giza 402 faba bean cvs.

Said (1998) applied 0, 15, 30 and 45 kg P_2O_5/fed and found a significant increase in number of branches/plant with the increase in P level. But increases in plant height were not significant.

Ghizaw *et al.* (1999) found that application of 23, 46 and 69 kg P_2O_5/ha as triple super phosphate in one year/and 23, 46 and 92 kg P_2O_5/ha in the other years, significantly increased plant height. The response of faba bean to P was evident. Shoot biomass and pods/plant compared to the control (0.0 P_2O_5)

Saad and El-Kholy (2000) found P application at 32 kg P_2O_5/fed significantly increased leaf dry weight and number of branches/plant of faba bean. They detected a significant correlation between P.

VI. Effect of mineral phosphorus fertilization on faba bean seed yield and its components:

Samia, El-Maghraby (1980) studied the effect of three P rates (0, 32 and 64 P_2O_5 kg/fed on faba bean). She found that the application of 64 kg P_2O_5 followed by 32 kg P_2O_5/fed give the highest value for seed, straw and biological yield/fed and significantly differed when compared to the control (0.0 P_2O_5 kg/fed) on the other hand, 100 seed weight and percentage of cotyledons to total seed significantly un affected by P rates but slight increment was shown as P rate increased up to 64 kg P_2O_5/fed for 100 seed weight and up to 32 kg P_2O_5/fed for percentage of cotyledons to total seed.

Salem and El-Massri (1986) found that application of 107.14 kg P_2O_5/ha to faba bean cvs Giza 1 and Giza 2 significantly increased number of pods/plant, 100-seed weight, seed yield/plant, and seed yield/ha.

Salem and El-Nakhlawy (1987) reported that application of 35.5 kg P_2O_5/ha significantly increased seed yield of faba bean.

Similar results were obtained by **Gomaa (1991),** (using 30 kg P_2O_5/fed), **Abdel-Raheem *et al.* (1992)**, (using 45 kg P_2O_5/fed), **Radwan (1992),**(using 60 kg/ha), **Abou-Salama and Dawood (1994)**, (using 37.5 kg P_2O_5/fed), **Hassanein (1995)**, (using 46.5 kg P_2O_5/fed), and **Shahein *et al.* (1995)**, (using 45 kg P_2O/fed).

Gomaa (1991) reported also that application of 30 kg P_2O_5/fed significantly increased seed yield/plant, and straw yield/fed of faba bean cv. Giza 2.

Abo El-Nour *et al.* (1996) reported hat the combination of seed inoculation and P application at 15 kg P_2O_5/fed generally promoted growth and significantly increased seed yield/fed

Hassanein (1995) concluded that P application at 46.5 kg/fed markedly increased weight of pods and seeds/plant, straw yield, seed yield and harvest index compared with the control and the lower P levels.

Hussein *et al.* (1997) concluded that the highest seed yield of faba bean, being, 2.23 tons/ha, was produced with the application of 74 kg P_2O_5/ha.

Ghizaw *et al.* (1999) treated faba bean plants with different levels of P as triple super phosphate (0, 23, 46 and 69 kg P_2O_5/ha) and found a positive linear response of seed yield to applied phosphorus.

Saad and El-Kholy (2000) reported a marked increase in seed yield of faba bean cv. Giza Blanka to P fertilization at a rate of 32 kg P_2O_5/fed The highest straw yield was also obtained at this rate.

They added that a clear increase was obtained in number of pods/plant and 100-seed weight.

Soheir, Mokhtar (2001) reported that the application of 31 kg P_2O_5/fed increased seed yield by 550 and 340 kg/fed compared to those receiving 15.5 and 23.25 kg P_2O_5/fed respectively. Straw yield followed a similar trend and seed index was also increased.

El-Douby and Samia, Mouhamed (2002) found that the application of 15, 30 and 45 kg P_2O_5/fed to faba bean significantly increased number of pods/plant (in one season), seed index (in one season) and seed yield as well as biological yields/fed in both seasons, but pods weight/plant significantly was unaffected by P application.

VII. Susceptibility and preferability of faba bean seeds to the storage insects:

Koura *et al.* (1971) studied the oviposition preference of *Callosobruchus maculatus* to six different stored pulses and found that cowpea seeds were the most suitable food. They also concluded that there was no relationship between the oviposition and the suitability of the seeds for insect development.

Singh (1976) tested the response of *C. maculatus* to seven species and/or varieties, namely pea, cowpea, lentil, Bengal gram, black gram, green gram, and red gram. He pointed out that the different varieties of any pulse did not influence the growth and development of the bruchids, but there were significant differences between the various pulses. The order was green gram, cowpea, red gram, Bengal gram, black gram, pea and lentil.

Singh *et al.* (1977), determined the ovipositional preference and development of *C. chinensis* on eight major pulses under laboratory conditions. They reported that the order of preference was calculated as an average number of eggs laid on different pulses. The suitability of the host seed for beetle development was judged from the mortality of the different stages.

The results indicated that percent mortality of egg stage was not significant in the different host seeds. The larvae and pupae mortalities were the lowest with mung followed by lentil, pea, and soybean and were found unsuitable for insect development.

Adults of *Callosobruchus maculatus, C. chinensis* or *Bruchidius incarnatus* were allowed to oviposite on seeds of field beans (*Vicia faba*), lentil and soybean for one week and the resulting eggs were then incubated. The maximum numbers of emergence holes per seed were 2, 3 and 12 for lentil, soybean and field bean, respectively (**El-Banby *et al.*, 1984)**.

Brewer and Horber (1984), tested 16 varieties of 7 species of some legumes for resistance to infestation by the bruchid *Callosobruchus chinensis*. Results revealed that the greatest damage was observed on mung bean (*Vigna radiata*) and the least on lentil, broad bean (*Vicia faba*), cowpea (*Vigna unguiculata*) and one variety of chickpea (*Cicer arietinum). Pigeon pea* [*Phaseolus angularis*, (*V. angularis*)] and most chickpeas were intermediate.

Ovipositional antixenosis in the resistant chickpea variety was due to the rough, almost spiny and pericarp. Antibiosis was expressed in lentil, broad bean and cowpea.

Shazali (1989), studied the oviposition and development of *Bruchidius incarnatus* and *Callosobruchus maculatus* on 7 seed legumes in an incubator at 30^{o}C and 70% RH. The legumes were faba bean (*Vicia faba*) chickpea (*Cicer arietinum*), cowpea (*Vigna unguiculata*), Pigeon pea (*Cajanus cajan*), haricot bean (*Phaseolus vulgaris*), pea and lupin [*Lupinus termis* (*L. albus*)]. The number of eggs laid varied significantly between the different legume species, although the potential fecundity of the 2 insect species was about the same. *B. incarnatus* laid most eggs on faba bean whereas *C. maculatus* laid most on pigeon pea. Egg survival was significantly affected by legume species, egg hatch of *B. incarnatus* was greatest (93.3%) on faba bean while egg hatch of *C. maculatus* was greatest (93%) on *Pigeon pea*. Percentage adult emergence was not significantly different between the 2 species of insects. Survival of both insect species was significantly influenced by the host and the interaction between insect species and host species. Chickpea was the most susceptible host to both insects, whereas cowpea was the most resistant to *B. incarnatus* and pea was the most resistant to *C. maculatus*. Both insects failed to develop on haricot bean and lupin. There was evidence that this was due to seed coat hardness in haricot bean and seed chemical composition in lupin.

Donger *et al.* (1993) evaluated seed of 24 accession of pigeon pea [*Cajanus cajan* (L.) Millsp] and four species of *Cajanus* (Formely Atylasia) for their resistance to infestation by *C.*

maculatus (F.), the results showed that significant resistance was evident in three species of *Cajanus*, where in *C. platycarpus*, most of the larvae failed to enter the hard seed coats but the few enter and developed normally. In *C. scarabaeoides* no adults emergence from the seed even thought most of the larvae entered the seeds. On the other hand, in *C. sericeus*, the number of larvae entering the seed as well as adults emergence was significantly reduced.

Sanaa, Mahgoub and Khalifa (1993), studied the susceptibility of 10 promising faba bean varieties to infestation by the cowpea weevil, *C. maculatus* (F.). Two pairs of insects were provided with 25 g of seeds from each variety and replicated three times. The number of eggs deposited per female, the percentage of emerged adults and the developmental period were recorded. Results showed obvious variation in the percentage of emerged adults, while the developmental period did not vary significantly. Seeds of N.A. 12 variety were most tolerant, while those of Giza 3 variety were most susceptible.

Mannan and Bhuiyah (1994) studied ovipositional rate of *C. maculatus* on mature pulse seed of cowpea, kidney bean, soybean, chickpea and artificial surfaces. Adult females preferred haricot bean. The highest number of eggs was laid on white seeds in darkness, while the lowest was on black seeds. The weevils preferred haricot bean for oviposition while chickpea gave the least response.

Nadia, Al-Aidy *et al.* (1995) evaluated correlation coefficients between some chemical and physical seed traits of some faba bean genotypes Giza 3, Giza 164, Giza Blanka and the germplasm accession NA 112. They are reported that there was a highly significant correlation between nitrogen free extract (NFE) content and insect infestation. The results also indicted that the germplasm accession NA112 had thicker and hard seed coat than other genotypes. Thus it might be more resistance to insect infestation compared to other genotypes.

Maldonado *et al.* (1996) tested seeds of 17 common bean cultivars for resistance to infestation by *Zabrotes subfasciatus* and *Acanthoseelides obtectus* under no choice and free choice conditions. To determine the relationship of some physical and chemical characteristics of the seeds and resistance to a bean weevil seed hardness, seed coat thickness tannins, lectin, trypsin inhibitors and protein content were evaluated. Three cultivars were resistance to *Z. subfasciatus* and non were resistance to *A. obtectus*. Correlations were found between lectin content and ovipostion and adult emergence indicating the importance of lectin for resistance. The resistant cultivars to *Z. subfasciatus* were Bayoeel-1 which showed intermediate values of seed hardness and lectin content and high level of seed coat thickness, tannin and trypsin content while Flor de Mayo Bajio variety showed the highest lectin content as well as well as high levels of seed coat thickness tannins content and trypsin inhibitors Bayo Victoria variety showed high levels of lectins and low levels of trypsin inhibitors.

Desroches *et al.* (1997) analysed the conditions of adaptation for *C. maculatus* population originating from West Africa on a new host plant, *Vicia faba*. When the females of *C. maculatus* oviposited on the seeds of *Vicia faba*, 2.45 of the larvae penetrated the cotyledons and complete their post-embryonic development, the other larvae died as soon as they began to consume the cotyledons. The presence of glucoside, vicine in the seeds of *Vicia faba* was main mortality factor, where vicine was hydrolysed by intestinal beta-glucosidase to divicine which has adverse effects on larval metabolism.

Rahman and Schmidt (1997) studied susceptibility of four pulses of cowpea, faba bean and two varieties of *Phaseolus vulgaris* to *C. phaseoli* infestation using choice and non-choice tests. The bruchid showed various responses to the seeds with regard to oviposition, larvae development and number of adult emergence.

Zein and Abo-Arab (2000) conducted laboratory experiments to study the degree of infestation by *Sitophillus oryzae* and *Rhizopertha dominica* on two wheat varieties, Sakha 8 and Sakha 92 priorly treated in the field with bio-organo fertilizers [Azotobacter inoculation (of grains) and/or farmyard manure (FYM) treatments (1% by weight)] under three levels of nitrogen fertilization (20%, 60% and 100% of recommended N dose, 70 kg N/fed) during 1997/98 and 1998/99 seasons. The obtained results showed that the degree of infestation and the mean of emerged adults of *S. oryza* were affected by the variety of wheat grain. On the other side, wheat variety had no effect on the mentioned parameters of *Rhizopertha dominica*. There were significant effects on the degree of infestation and the number of progeny of both *S. oryzae* and *R. dominica* as result of different levels of nitrogen fertilization and combination of bio- organofertilizers on both tested varieties of wheat Sakha 8 and Sakha 92. *R. dominica* caused the highest infestation on both wheat varieties, comparing with *S. oryzae*. These findings show that the level and the kind of fertilizer had some effect on the degree of infestation and number of progeny of the two tested insects for the two used wheat varieties.

Venugopal *et al.* (2000), carried out a study to categorize the seeds of various wild and cultivated grain legume varieties on the basis of their relative resistance to the bruchid *C. maculatus* and to correlate the important primary and secondary metabolites (non-protein, anti-metabolites) in these seeds to the developmental parameters of the bruchid. In general, the wild seed varieties showed greater amount of resistance to the bruchid attack when compared to that of the cultivated varieties. All the cultivated varieties studied showed higher amounts of primary metabolites, namely, proteins, carbohydrates, lipids and free amino acids, thus showing a positive correlation between the primary metabolites content and the infestation rate. The wild varieties, however, showed significantly lower amounts of these primary metabolites and consequently a lower level of infestation.

Umrao and Verma (2002), tested twenty pea cultivars against *C. chinensis*. The studies were made between physical character (hardness, moisture and damaged grain) and fecundity, F_1 progeny and index susceptibility. Grain hardness showed a significant negative correlation with F_1 progeny (-0.785) and index susceptibility (-0.984). An increase in hardness decreased growth and development of *C. chinensis*. Grain moisture content exhibited a significant positive correlation with fecundity (0.517) and index susceptibility (0.499), which indicates that an increase in moisture content will increase the growth of *C. chinensis*. The loss in weight and damaged grain showed a significant positive correlation with F_1 progeny and index susceptibility, where an increase in fecundity, F_1 progeny, and index susceptibility increased the loss in weight and damaged grain.

Ali *et al.* (2004), screened sixteen seed varieties of broad bean crop for their relative susceptibility of resistance against infestation by the two storage bruchids, *C. chinensis* and *C. maculatus* under no-choice condition. According to fecundity, eggs hatching (%), mean developmental period (MDP), adult emergence (%) and the values of susceptibly index (SI). The weight loss was also calculated on the dry weight basis. The results revealed that the seed varieties were more susceptible to infestation by *C. chinensis* than *C. maculatus* in respect to the values of the susceptibility index (SI) and weight loss.

Luciana *et al.* (2004) reported that the seeds of common bean (*Phaseolus vulgaris* L.) don't support development of the bruchid *C. maculatus* F. Analysis of the testa (seed coat) showed that phseolin (vicinlin-like 75 globulin) detected in the testa and N-terminal amino acid determinal to the development of *C. maculatus*. They also suggested that the presence of vicilin-like proteins found in the testa had a significant role in the evolutionary adaptation of the bruchids to the seeds of leguminous plants.

Somta, *et al.* (2005) studied that resistance to a Zuki bean weevil, *Callosoruchus chinensis*, was studied in a series of field and laboratory experiments in two accessions of rice bean *Vigna umbellate* (Thunb.). The reported that results implied that antibiosis factors present in the seed coat or seed cotyledon might be responsible for resistance to *C. chinensis*. At times they found dead larvae and pupae in cotyledons or near the embryonic axis of all resistant accessions.