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Research Article

SURVIVAL AND DEVELOPMENT OF POD BORER, *Helicoverpa armigera* (Hub.) ON DIETS IMPREGNATED WITH DIFFERENT GENOTYPES OF CHICKPEA/PIGEONPEA LEAF AND POD POWDERS

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Abstract: Legume pod borer, *Helicoverpa armigera* is a major pest of chickpea, cotton, pigeonpea, sunflower, tomato, vegetables and other pulse crops and has been reported to attack more than 181 cultivated plants. Artificial diets impregnated with different genotypes of lyophilized chickpea leaf and pod powders were fed to gram pod borer and results revealed that the genotypes, CRIL 2-17, ICC 10393, ICC 506, ICCL 86111, RIL 25 and ICC 3137 were suitable for the *H. armigera* growth and development and recorded 100 % larval survival. CRIL 2-13 was found resistant against the gram pod borer and not supported (only 70% survival) the growth and development of larvae among the ten cultivars and standard diet check. The adult emergence percent was very less and ranged from 4.2 to 37.5 in the tested genotypes against 75% in standard artificial diet. Larval and pupa periods were prolonged to 25.5 and 18.8 days, respectively compared to the standard artificial diet (16.2 and 11.3 days, respectively). It was evident that chickpea genotypes tested were resisted the complete development of pod borer and very less percent of larvae grown were turned to adult. In pigeon pea genotypes incorporated impregnated diets, the lowest larval survival (62.5%) was found in ICPW 125 and the highest in standard artificial diet. Adult recovery percentage (20.8-41.7 %) was also low in case of pigeonpea genotypes leaves/pod powder incorporated diets as against the standard artificial diet (79.2 %). The larval and pupal periods were prolonged and some larvae were remained in larval stage till death and pupa were unable to give the adults in pigonpea leave/pod powder impregnated diets. Differences in survival and development of *H. armigera* on different pigeonpea genotypes have also been expressed by several workers in their earlier studies and these differences may also be due to biochemical changes in the nutritional quality of the pigeonpea plant parts impregnated in artificial diets.

Keywords: Pod borer, *Helicoverpa armigera*, Chickpea/Pigeon pea genotypes, Survival and Development

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Introduction

The Cotton bollworm/legume pod borer, *Helicoverpa armigera* (Hübner) (*Lepidoptera: Noctuidae*) is one of the most devastating crop pests' worldwide [1, 2]. It has been reported to attack more than 181 cultivated and uncultivated species of plants [3]. It is a major pest of Cotton, chickpea, pigeonpea, sunflower, tomato, vegetables and other pulse crops. The crop losses due to this pest range from 10-80% in terms of pod damage in chickpea [4]. It has been estimated to cause a loss of US$328 million annually in the semi-arid tropics [5] and US$2 billion on other crops worldwide [2]. The chemical composition of host plants significantly affects survival, growth and reproduction of phytophagous insects [6]. In phytophagous insects, the availability of different hosts plays an important role in triggering population outbreaks [7]. The development, survival, reproduction and life table parameters of insects are influenced by host plant type [8-10]. It is evident from the research that, the plants will release physical and volatile signals to attract the insects to its surface and whereas chemical and nutritional factors of the food substrates of plants will determine the consumption, development and survival of insects in larval stages and egg production of subsequent adult stages [11]. Survival and development of *H. armigera* on the two food substrates, fresh leaves and pods of chickpea and artificial diet with lyophilized leaf or pod powder were highly correlated suggesting that incorporation of lyophilized leaves or pods into the artificial diet can be used to assess antibiosis to *H. armigera* in chickpea [12].

Chickpea germplasm accessions with resistance to *H. armigera* have been identified by several workers [13,14,15,16,17]. However, the genotypic responses have been found to be quite variable across seasons and locations [18]. There is a need to identify genotypes with different mechanisms (genes) of resistance to develop chickpea cultivars with stable resistance to *H. armigera* [19]. Resistance genes from diverse sources need to be combined to increase the levels (gene pyramiding), and diversify the bases of resistance to this pest. To achieve this objective, there is a need to conduct diet impregnation assay to evaluate chickpea genotypes for antibiosis component of resistance to *H. armigera* in chickpea. The present study aimed, the survival and development of *H. armigera* on different chickpea/pigeonpea pod powder incorporated diets to know the characteristic developments in the *H. armigera*.

Materials and Methods

To find out the effect of chemical stimuli from the host plant on feeding and development of *H. armigera*, lyophilized leaves and pod powder of different chickpea, pigeonpea genotypes was incorporated into the artificial diet and fed to the *H. armigera* larvae. The chickpea and pigeonpea leaves and pods were collected in the morning and lyophilized. After lyophilization, the leaves and pods were made into a fine powder in the blender and stored till used in the artificial diet.

The lyophilized powder (25g) was mixed into the diet as a replacement for equivalent amount of chickpea flour. The diet was prepared and poured into the cell wells, which were then kept under a laminar air flow with UV light for solidification. Four replications were maintained in the experiment. Twenty neonate larvae were released individually into the cell wells with a camel hair brush, and cell wells were covered with a cling film to avoid the escape of neonate larvae. Data were recorded on larval survival, larval and pupal periods, pupation, adult emergence and fecundity. Pair of male and female moths were released in to an oviposition cage to study the fecundity.

Results and Discussion

Effect of different diets impregnated with lyophilized chickpea (leaf and pod powder) genotypes on survival and development of *H. armigera*

Lyophilized leaves and pod powder of different chickpea genotypes was incorporated into the artificial diet, and fed to the *H. armigera* larvae to find out the effect of chemical stimuli from the host plant on development and survival of *H. armigera*. Results indicated that there was 100% larval survival in insects fed on diets amended with chickpea genotypes, CRIL 2-17, ICC 10393, ICC 506, ICCL 86111, RIL 25 and ICC 3137. The lowest larval survival was observed in the diet containing chickpea genotype CRIL 2-13. There were significant differences in larval weights when the larvae were reared on diets with leaf/pod powder of different chickpea genotypes. The larval weights ranged from 86.9 to 355.6 mg, and the maximum larval weight (355.6 mg) was recorded in insects reared on the standard artificial diet. Even though the larval survival was maximum, the larval development was poor in the diets with leaf/pod powder of different chickpea genotypes. There was 50 - 75% decrease in the larval weights in the larvae reared on diets with chickpea genotypes as compared to the larvae reared on standard artificial diet. The larval period ranged from 20.3 to 25.5 days in chickpea genotype incorporated diets. The larval period was extended in the insects reared on diets with chickpea genotypes, CRIL 2-13, RIL 20, ICCV 10 and ICC506EB as compared to the larvae reared on the standard artificial diet (16.2 days) [Table-1].

Table-1 *Effect of different diets impregnated with lyophilized chickpea (pod powder) genotypes on survival of H.armigera*

Chickpea genotypes	Larval survival (%)	Pupal recovery (%)	Adult emergence (%)
CRIL 2-13	70.8	62.5	1250%
CRIL 2-17	100	70.8	1250%
ICC10393	100	83.3	420%
ICC 506	100	62.5	830%
ICCL 86111	100	75	1670%
ICCV 10	91.7	66.7	16.7
RIL 20	95.8	62.5	12.5
RIL 25	100	62.5	25
ICC 3137	100	87.5	29.2
KAK 2	95.8	83.3	37.5
Standard artificial diet	91.7	87.5	75
Fp (10, 33)	<0.001	0.04	<0.001
Vr	8.47	4.35	13.85
SE±	0.18	0.3	0.31
LSD (P 0.05)	0.52	0.84	0.88
CV (%)	6.3	13.89	46.9

The pupal recovery ranged from 62.5 - 87.5%. Pupation decreased in insects reared on diets having leaf/pod powder of chickpea genotypes. Even though the larvae completed the six instars, did not moult into the pupal stage. Pupation was maximum in insects reared on standard artificial diet (87.5%), followed by those fed on diets with ICC 3137 (87.5%), and KAK 2 (83.5%) incorporated diets. The pupal weights ranged from 31.9 to 304.9 mg. Maximum pupal weights were recorded in insects reared on the standard artificial diet (304.9 mg), followed by those reared on diets containing ICC 10393 leaf/pod powder (93.1 mg). The pupal period was also prolonged in the chickpea genotypes incorporated diets. The longer pupal period was recorded in the diets with ICCV 10, ICCL 86111, CRIL 2-17 and ICC 3137 as compared to those reared on the standard artificial diet (11.3 days). The adult emergence ranged from 4.2 to 75%, and the diet containing CRIL 2-13 leaf/pod powder has less supportive of *H. armigera* development, and recorded only 4.2% adult emergence. Maximum adult emergence (75.0%) was observed in the insects reared on the standard artificial diet [Table-1].

Table-2 *Effect of different diets impregnated with lyophilized chickpea (pod powder) genotypes on development of H.armigera*

Chickpea genotypes	Larval weight at 10thday (mg)	Pupal weight (mg)	Larval period (days)	Pupal period (days)
CRIL 2-13	160.3	65.4	2550%	16.4
CRIL 2-17	114.6	77.3	2080%	17.5
ICC10393	155.9	93.1	2150%	16.1
ICC 506	121.6	72.5	2430%	17.5
ICCL 86111	139.7	72.8	2510%	18.1
ICCV 10	157.8	75.6	24.6	18.8
RIL 20	86.9	31.9	25.1	16.5
RIL 25	141.8	70.1	22.6	16.5
ICC 3137	109	69	23	17.5
KAK 2	87.7	38.8	20.3	16.3
Standard artificial diet	355.6	304.9	16.2	11.3
Fp (10, 33)	<0.001	<0.001	<0.001	0.04
Vr	8.84	511.5	12.15	4.1
SE±	24.76	3.26	0.83	1
LSD (P 0.05)	71.05	9.05	2.32	2.7
CV (%)	33.4	7.39	7.49	11.6

Table-3 *Effect of different diets with lyophilized pod powder of different pigeonpea genotypes on survival of H. armigera*

Pigeonpea genotype	Larval survival (%)	Pupal recovery (%)	Adult emergence (%)
ICPL 87	75	50	2080%
ICPL 87119	75	62.5	3750%
ICPL 7035	66.7	45.8	2500%
LRG 41	66.7	50	2500%
ICPL 84060	70.8	54.2	29.2
ICPL 332 WR	79.2	54.2	25
ICPL 87091	87.5	70.8	41.7
ICPW 125	62.5	50	25
Hairy pods	66.7	58.3	29.2
T 21	75	66.7	29.2
Standard artificial diet	91.7	83.3	79.2
Fp (10, 33)	0.02	0.04	<0.001
VR	4.4	2.9	13.3
SE±	0.26	0.4	0.27
LSD (P 0.05)	0.72	1.1	0.74
CV (%)	11.7	22.51	26.83

There are considerable differences in numbers of *H. armigera* larvae on different genotypes under field conditions [13,15]. Antibiosis is expressed in terms of larval mortality, decreased larval and pupal weights, prolonged larval and pupal development, failure to pupate and reduced fecundity and egg viability [20]. Larvae of *H. armigera* reared on leaves or pods of ICCV 7 weighed significantly lower than those reared on ICCC 37, while the pupal weights were lower in larvae reared on ICC 506 and ICCV 7 than those reared on ICCC 37 [21]. Research revealed that survival and development of *H. armigera* on the two food substrates, fresh leaves and pods of chickpea and artificial diet with lyophilized leaf or pod powder, were highly correlated and suggested that incorporation of lyophilized leaves or pods into the artificial diet can be used to assess antibiosis to *H. armigera* in chickpea [12]. In the present studies, even though the larval mortality was less in the different chickpea leaf/pod powder impregnated diets.

As compared to the standard artificial diet, further development was slow. Larval weights were lower in diets with leaf/pod powder of CRIL2-17, RIL 20, ICC 3137, KAK 2, and ICC 506EB than the diets with ICC86111 and ICCV 10 leaf/pod powder. It was observed that the *H. armigera* larvae reared on artificial diets incorporated with lyophilized leaf and/or pod powder of chickpea genotypes ICC 12475, ICC 12476, ICCV 2, and ICC 12479 weighed significantly lower than those fed on diets impregnated with leaf and/or pod powders of ICC 12426 and ICC 3137 [12]. The slower larval growth was also observed in diets with leaf/pod powder of chickpea genotypes CRL2-13, ICC506EB, ICC86111, and ICCV 10. It was also noticed that the larval period was prolonged on fresh leaves/pods of ICC 506EB, and in diets with pod powder of ICC 3137, ICC 12479, ICCV 2 and ICC 506. Pupation, pupal weights and adult recovery decreased in the insects reared on diets impregnated with leaf/pod powder of different chickpea genotypes as compared to that on the standard artificial diet. The *H. armigera* survival and development were adversely affected when the larvae were reared on diets containing leaf/pod powder of different chickpea genotypes. Chemical and nutritional factors of the food substrate determine consumption, development and survival in the larval stages and egg production of subsequent adults [11]. Growth inhibitor and/or antifeedant substances in chickpea leaves/pods might contribute to antibiosis to *H. armigera* in chickpea [22]. Slower larval growth, which results in prolonged development, may also increase the probability of predation, parasitism, and infection by pathogens, resulting in reduced population of this pest on chickpea.

Effect of different diets impregnated with lyophilized pigeonpea (leaf and pod powder) genotypes on survival and development of *H. armigera*

The effect of chemical stimuli from the host plant on feeding and development of *H. armigera* was also studied by impregnating the lyophilized leaves/ pod powder of different pigeonpea genotypes into the artificial diet, and fed to the *H. armigera* larvae. The results indicated that there were significant effects of pigeonpea genotypes on the survival and development of *H. armigera*. The larval survival ranged from 62.5 % in diets with leaf/pod powder of ICPW 125 to 91.7 % in the standard artificial diet [Table-3].

Table-4 *Effect of different diets with lyophilized pod powder of different pigeonpea genotypes on development of H. armigera*

Pigeonpea genotype	Larval period (days)	Pupal period (days)	Larval weight(mg)	Pupal weight (mg)
ICPL 87	21.4	17	28710%	134.7
ICPL 87119	23.3	17	20180%	164.6
ICPL 7035	22	16.5	19180%	130.8
LRG 41	22.6	17	20160%	154
ICPL 84060	23.8	17.8	239.2	152.6
ICPL 332 WR	25	18.3	224.6	128.7
ICPL 87091	22.4	14.9	226.9	167.8
ICPW 125	22	16.8	179.8	123.8
Hairy pods	21.8	16.3	223.5	143.8
T 21	21.1	17.1	240.2	166.4
Standard artificial diet	15.1	9.8	342.8	275.2
Fp (10, 33)	<0.001	0.01	0.01	0.01
VR	14.9	8.9	10.86	9
SE±	0.64	0.76	14.15	13.94
LSD (P 0.05)	1.79	2.13	39.22	38.62
CV (%)	5.91	9.49	12.17	17.59

The larval survival decreased significantly in diets with the pigeonpea pod powder incorporated diets. There was 25 - 32% decrease in larval survival when the insects were reared on pigeonpea pod powder incorporated diets as compared to the standard control diet. Amongst the 10 genotypes tested, the larval survival was highest (87.5%) in diets with ICPL 87091 leaf/pod powder and the least larval survival (62.5%) was observed in diets with ICPW 125 pod powder impregnated diet. The larval development was also significantly affected by the pigeonpea genotypes. The larval weights ranged from 179.8 to 342.8 mg. The highest larval weights were observed in insects reared on the standard artificial diet. The larval weights were comparatively lower in larvae reared on pigeonpea pod powder impregnated diets. Amongst the 10 genotypes tested, the least larval weight was recorded in diets with ICPW 125 leaf/pod powder (179.8 mg), followed by ICPL 7035 (191.8 mg) [Table-4]. Highest larval weights were recorded in insects reared on diets impregnated with ICPL 87 genotype (287.1 mg). The larval developmental period was also prolonged in the pigeonpea incorporated diets as compared to the standard control diet. The larval period was longer in the ICPL 332 WR amended diet (25.0 days), followed by ICPL 84060 (23.8 days). The shortest larval period was observed in the standard artificial diet (15.1 days). Percentage pupation ranged from 50.0 to 83.3%. The pupation was lower in the larvae reared on the pigeonpea pod powder incorporated diets. The highest pupation was recorded in the insects reared on the ICPL 87091 (70.8%) pod powder impregnated diets [Table-3]. Only 50% pupation was recorded in diets amended with pod powder of ICPL 87, and ICPW 125. There were significant differences in pupation in diets amended with different pigeonpea genotypes. The pupal weights were maximum in the insects reared on the standard artificial diet (275.2 mg), followed by those reared on diets amended with ICPL 87091 pod powder (167.8 mg) [Table-4]. Pupal period was also prolonged in diets with pod powder of different pigeonpea genotypes. The pupal period lasted for 9.8 days in insects reared on the standard artificial diet but was extended up to 18.3 days in diets with pod powder of ICPL 332WR and 17.8 days in ICPL 84060 [Table-2]. Of the 10 genotypes tested, the pupal period was shortest in insects reared on ICPL 87091impregnated diet. Adult emergence was adversely affected when the insects were reared on the pigeonpea pod powder impregnated diets. The adult emergence decreased drastically and only 20.8 to 41.7% adult mergence was recorded in the pigeonpea pod powder impregnated diets. In the standard artificial diet, the adult emergence was 79.2%. In the present studies, the larval and pupal development was poor in diets amended with pod powder of different pigeonpea genotypes as compared to the standard artificial diet. The larval and pupal weights were lower in insects reared on diets with pod powder of ICPL 7035, LRG 41, ICPL 84060, ICPW125 and T21 as compared to ICPL 87091, ICPL 87 amended diets. The larval and pupal periods were also extended. In the earlier studies, it was reported that, reduced larval and pupal weights and prolonged larval and pupal periods in insects reared on diets with pod powder of ICPL 332WR, ICPL 84060, ICP 7035, ICPL 88039 and T 21 as compared to those reared on ICPL 87 and ICPL 87091 amended diets [23]. Reduction in larval and pupal weights and prolongation of larval and pupal periods have been observed in insects fed on developing pods of resistant genotypes (24,25,26]. Differences in survival and development of *H. armigera* on different pigeonpea genotypes have also been reported by [27].

Application of research: The present studies have shown that there were significant differences in survival and development of *H. armigera* larvae reared on diets with pod powder of different pigeonpea genotypes. The reason for the differences in survival and development of *H. armingera* may be do due to biochemical changes in the nutritional quality of the pigeonpea plant parts which were impregnated in artificial diets.

Research Category: Chickpea/Pigeon pea genotypes

Abbreviations:
LSD: Least Significant Difference
CV: Coefficient of Variation

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