

Response of Different Chickpea (*Cicer arietinum*) Genotypes to the Infestation of Pod Borer (*Helicoverpa armigera*) with Relation to Trichomes

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Abstract: Twelve gamma radiated genotypes of chickpea (*Cicer arietinum*) NIFA-95 (10krad), NIFA-95 (20krad), NIFA-95 (30krad), NIFA-95 (40krad), Pb-91 (10krad), Pb-91 (20krad), Pb-91 (30krad), Pb-91 (40krad), Hassan-2k (10krad), Hassan-2k (20krad), Hassan-2k (30krad), and Hassan-2k (40krad) were screened against *Helicoverpa armigera* in a field trial. The data were recorded on the basis of number of trichomes, plants height, pod borer larval population and percent pod damage at different phenological stages of genotypes. Higher doses resulted in maximum number of leaf trichomes and plant height. Hassan-2k (40krad) produced highest number of leaf trichomes at pre-flowering, flowering and podding stages respectively. Pb-91 (20krad) resulted in minimum trichomes at pre-flowering while Pb-91 (10krad) at flowering stage. Tallest plants were recorded in Hassan-2k (40krad) at all stages of plants and shortest was NIFA-95 (10krad) being. Minimum larval population of 20 numbers was observed on Hassan-2k (40krad) while maximum was recorded on NIFA-95 (10krad). Percent damage was highest in Hassan-2k (10krad) and lowest in Pb-91 (20krad). Maximum yield was recorded on Hassan-2k (30krad). Trichomes and height were negatively correlated with *Helicoverpa armigera* infestation. Pb-91 (20krad) is recommended as tolerant to the infestation of *Helicoverpa armigera*.

Key words: Chickpea, Pod borer, *Helicoverpa armigera*, Trichomes, Phenological stages

INTRODUCTION

Chickpea, *Cicer arietinum* (Family *Leguminosae*, sub tribe *Cicerea*) locally known as gram, is an ancient cultivated plant known in different countries as gram, chickpea, grabanzo, homms, chana etc. Chickpea probably originated in Southeastern Turkey near Syria, from where it is distributed to African, Asian and Mediterranean countries including Pakistan. It is now also grown in Australia and America. There are two main categories of chickpea are distinguished, based primarily on seed characteristics: the (Desi) types, having relatively small, angular seeds with rough, usually yellow to brown testa and the (Kabuli) types, which have larger, more rounded and cream colored seeds^[1].

In Pakistan chickpea is cultivated mostly in the sandy desert and semi-arid zones where it plays a dominant role in subsistence farming system. It occupied an area of about 0.97 million ha with an annual production of 0.56 million tones in the country^[2]. Being a cheap source of protein for poor man, chickpea is receiving high attention in yield improvement. In Pakistan the yield of chickpea is very low. The low yield could be attributed to many factors including insect pests. Gram pod borer,

Helicoverpa armigera (Lepidoptera; Noctuidae), is considered as notorious pest of chickpea. Besides gram pod borer, it is also known as cotton bollworm, gram caterpillar, tomato fruit worm and tobacco bud worm^[3].

Helicoverpa armigera is found between parallel of 50° north and south latitude. The adult of *Helicoverpa armigera* is of 4.45 cm in size. Its wings are pale reddish brown, olive, greenish tinge on outer margin with darker bands and spots. A single female could deposit 500-3000 eggs, larvae emerge in 2-10 days, after passing 6 or 7 instars they pupate in ground and adult emerge in spring. They first feed on surface of plant leaf but later on they bore into through tender place. The first instar larva feed on upper surface of leaflets, while the large larvae chew a circular hole in the pod wall and then consume the seeds. The caterpillar not only damages pod but also feeds on foliage, bud and flowers^[3].

Pod borer attracts towards chickpea because of the concentration of malic acid which is present in its trichomes. Trichomes are hair present on epidermis of plant^[4]. Many researches have been carried out to know the influence of these trichomes on *Helicoverpa armigera*. This study was conducted to know the response of certain chickpea varieties, after treating with

different doses of radiation, against pod borer with respect to trichomes.

MATERIALS AND METHODS

To check the response of different chickpea genotypes to the infestation of pod borer (*Helicoverpa armigera*) with relation to trichomes, an experiment was conducted in Entomology Division at the Nuclear Institute for Food and Agriculture (NIFA) Peshawar in the year 2002 till 2003. Seeds of three different varieties were obtained from crop breeding division of NIFA. Each variety was divided in to 5 groups, and was treated with four gamma radiation dosages and compared with control.

A) NIFA-95	B) Pb-91	C) Hassan-2k
i) 10 kr	i)10 kr	i) 10 kr
ii) 20 kr	ii) 20 kr	ii) 20 kr
iii) 30 kr	iii) 30 kr	iii)30 kr
iv) 40	kr iv) 40 kr	iv)40 kr
v) Control	v) Control	v) Control

These 12 genotypes were sown in split plot design in a field trail. Each sub plot was of 16 m² having 10 rows. As each genotype was planted in its respective sub plot therefore it made 12 sub plots. Each sub plot was divided in 5 stations. From each station 2 plants were selected, this made 10 replicates from each plot.

Counting of No. of trichomes per leaf: After germination and before flowering No. of trichomes per leaf were counted under microscope. From each plant 3 leaves (top, middle and bottom) were cut and brought to lab for trichomes counting. These were counted under binocular microscope of 30X and light intensity up to 100 candle lights. This practice was repeated in each phenological stage of plant.

Height of plant: Height of plant was observed in each phenological stage and measured in centimeters.

Counting No. of Eggs per plant: After observing first egg laying, field eggs counting was started. This observation was carried out from 26th March 2002 to 2nd May 2002, at two days interval.

Counting No. of larvae per plant: After one week of egg laying, counting of larval population, according to larval instars, was started. This observation continued from 9th April 2002 to 2nd May 2002 after two days interval.

Percent pod damage: At the end of season percent pod damage was examined. From each plot five plants were

selected randomly and obtain percent pod damage by following formula.

$$\text{Percent Pod damage} = \frac{\text{Damage No. of pods/plant}}{\text{Total No. of pods/plant}} \times 100$$

Yield: After harvesting, yield was obtained and calculated as kg ha⁻¹. It gave an overall index of the treatments.

RESULTS AND DISCUSSIONS

Number of Trichomes on leaves at different phenological stages: Numbers of trichomes on leaves of 12 genotypes at pre-flowering, flowering and podding stage were significantly (P<0.05) different. The highest numbers of trichomes at this stage were recorded on Hassan-2k (40krad) i.e. 303.2, while the lowest numbers of trichomes were recorded on Pb-91 (20krad) i.e.149.4 (Table 1). The number of trichomes ranges from 186.1 on Pb-91 (10krad) to 362.1 on Hassan-2k (40krad) which was significantly (P<0.05) different among the 12 genotypes tested (Table-2). The data in Table 3 clearly shows that the highest number of trichomes at this stage were recorded on Hassan-2k (40krad) (383.1) followed by Hassan-2k (30krad) (355.6), Hassan-2k (20krad) (329.2), Hassan-2k (10krad) (293.2), Pb-91 (40krad) (274) and NIFA-95 (20krad) (267.9). The lowest numbers of trichomes were recorded on Pb-91 (20krad) (222.3) followed by Pb-91 (10krad) (228.5), Pb-91 (30krad) (252.8), NIFA-95 (40krad) (258.9), NIFA-95 (30krad) (259.1) and NIFA-95 (10krad) (259.9). There fore, at pre-flowering stage Hassan-2k (40krad) had highest number of trichomes where as Pb-91 (20krad) had the lowest number of trichomes. Control in comparison to radiated genotypes had minimum number of trichomes at pre-flowering, flowering and podding stages.

Height of plant at different phenological stages: Heights of these tested genotypes were recorded at different phenological stages of plants in centimeters. At pre-flowering stage the highest plant was Hassan-2k (40krad) which was 50 cm, while the smallest recorded plant was NIFA-95 (10krad) which was 38.2 cm (Table 4). At flowering stage (Table 5) the maximum height was attained by Hassan-2k (40krad) (69.3 cm), followed by Hassan-2k (30krad) (68.6 cm), Hassan-2k-20 (67.3 cm), Hassan-2k (10krad) (67.2 cm), Pb-91 (40krad) (64.3 cm) and NIFA-95 (30krad) (62.9 cm). The smallest recorded plant was NIFA-95 (10krad) (53.1 cm), followed by Pb-91 (20krad) (59.7 cm), NIFA-95 (20krad) (60.4 cm), Pb-91 (30krad) (61.5 cm), NIFA-95 (40krad) (61.9 cm) and Pb-91 (10krad) (62.3 cm). Similarly in the context of height, at podding stage the highest plant was Hassan-2k (40krad) (79.7 cm), while the smallest recorded plant was NIFA-95 (10krad) (64 cm)

Table 1: Number of trichomes on leaves at pre-flowering stage at various doses with respect to varieties

Dose (Krad)	NIFA-95	Pb-91	Hassan-2k	Mean Dose Effect
10	191.6 _{fg}	152.2 _i	233.3 _c	192.4 _a
20	201 _{ef}	149.4 _i	263.4 _b	204.6 _a
30	192.5 _{fg}	182.4 _{gh}	268.4 _b	214.4 _a
40	215.6 _{de}	211.3 _{de}	303.2 _a	243.4 _a
Control	170.3 _{hi}	140.6 _i	227.4 _{cd}	179.4 _a
Mean Var.	194.2 _a	167.2 _a	259.1 _a	

LSD at 5% for means of Trichomes numbers at pre-flowering stage = 16.39

LSD at 5% for Mean Dose Effects = 165.1

LSD at 5% for Mean Var. = 643.1

Means followed by same letters are not significantly different at 0.05% level of significance.

Table 2: Number of trichomes on leaves at flowering stage

Dose (Krad)	NIFA-95	Pb-91	Hassan-2k	Mean Dose Effect
10	230.4 _{gh}	186.1 _i	262.3 _d	226.3 _a
20	238.6 _{efg}	190.1 _i	307.6 _c	245.4 _a
30	226.5 _{gh}	218.8 _h	336.1 _b	260.5 _a
40	221.2 _{gh}	241.6 _{ef}	362.1 _a	275.0 _a
Control	215.1 _{hi}	160.8 _j	251.3 _{de}	209.1 _a
Mean Var.	226.4 _a	199.5 _a	303 _a	

LSD at 5% for means of Trichomes numbers at flowering stage = 16.73

LSD at 5% for Mean Dose Effects = 178.8

LSD at 5% for Mean Var. = 737.6

Means followed by same letters are not significantly different at 0.05% level of significance

Table 3: Number of trichomes on leaves at podding stage

Dose (Krad)	NIFA-95	Pb-91	Hassan-2k	Mean Dose Effect
10	259.9 _{ef}	228.5 _{hi}	293.2 _d	260.5 _a
20	267.9 _{ef}	222.3 _i	329.2 _c	273.1 _a
30	259.1 _{ef}	252.8 _{fg}	355.6 _b	289.2 _a
40	258.9 _{ef}	274 _a	383.1 _a	305.3 _a
Control	240.3 _{gh}	200.4 _j	263.5 _{ef}	234.7 _a
Mean Var.	257.2 _a	235.6 _a	324.9 _a	

LSD at 5% for means of Trichomes numbers at podding stage = 16.23

LSD at 5% for Mean Dose Effects = 183.9

LSD at 5% for Mean Var. = 634.0

Means followed by same letters are not significantly different at 0.05% level of significance

Table 4: Height of plants at pre flowering stage

Dose (Krad)	NIFA-95	Pb-91	Hassan-2k	Mean Dose Effect
10	38.2 _f	42.9 _e	48 _{cd}	43.03 _a
20	44.6 _{de}	42.8 _e	48.7 _c	45.37 _a
30	47.4 _{cd}	44.4 _{de}	49.3 _c	47.03 _a
40	47.2 _{cd}	46.2 _{cde}	50 _b	47.8 _a
Control	52.9 _b	57 _a	57.20 _a	55.70 _a
Mean var	46.06 _a	46.6 _a	50.64 _a	

LSD at 5% for means of height at pre-flowering stage = 3.365

LSD at 5% for Mean Dose Effects = 32.5

LSD at 5% for Mean Var. = 33.87

Means followed by same letters are not significantly different at 0.05% level of significance

(Table 6). Control in comparison to radiated genotypes attained maximum height at different phenological stages.

Effect of radiated genotypes on Population of *Helicoverpa armigera*: The larval population of *Helicoverpa armigera* was significantly (P<0.05) different among genotypes (Table 7). The highest numbers of larval population was

Table 5: Height of plants at flowering stage

Dose (Krad)	NIFA-95	Pb-91	Hassan-2k	Mean Dose Effect
10	53.1 _f	62.3 _e	67.2 _{bcd}	60.87 _a
20	60.4 _e	59.7 _e	67.3 _{bcd}	62.47 _a
30	62.9 _{de}	61.5 _e	68.6 _{bc}	64.33 _a
40	61.9 _e	64.3 _{cde}	69.3 _b	65.17 _a
Control	63.2 _e	74.1 _a	74.3 _a	70.53 _a
Mean Var.	60.30 _a	64.38 _a	69.34 _a	

LSD at 5% for means of height of chickpea at flowering stage = 4.083

LSD at 5% for Mean Dose Effects = 25

LSD at 5% for Mean Var. = 61.60

Means followed by same letters are not significantly different at 0.05% level of significance

Table 6: Height of plants at podding stage

Dose (Krad)	NIFA-95	Pb-91	Hassan-2k	Mean Dose Effect
10	64 _f	72.4 _{de}	78 _b	71.47 _a
20	71.5 _{de}	69.8 _e	76.4 _{bc}	72.57 _a
30	72 _{de}	70.2 _{de}	79.3 _b	73.83 _a
40	72.2 _{de}	74 _{cd}	79.7 _b	75.3 _a
Control	74 _{cd}	85.4 _a	84.8 _a	81.40 _a
Mean Var	70.74 _a	74.36 _a	79.64 _a	

LSD at 5% for means of height of chickpea at podding stage = 3.59

LSD at 5% for Mean Dose Effects = 26.51

LSD at 5% for Mean Var. = 60.90

Means followed by same letters are not significantly different at 0.05% level of significance

Table 7: Effect of these tested varieties on population of *Helicoverpa armigera*

Dose (Krad)	NIFA-95	Pb-91	Hassan-2k	Mean Dose Effect
10	32.8 _{cd}	32.4 _{cd}	24.1 _{efg}	29.7 _a
20	29.2 _{de}	28.7 _{de}	22 _{fg}	26.6 _a
30	25.6 _{ef}	31.1 _d	20.3 _g	25.6 _a
40	27.5 _{de}	29 _d	20 _g	25.5 _a
Control	41.2 _b	46.3 _a	36.5 _c	41.33 _a
Mean Var.	31.26 _a	33.5 _a	24.5 _a	

LSD at 5% for means population of *Helicoverpa armigera* = 4.676

LSD at 5% for Mean Dose Effects = 45.45

LSD at 5% for Mean Var. = 63.14

Means followed by same letters are not significantly different at 0.05% level of significance.

Table 8: Percent damage caused by *Helicoverpa armigera*

Dose (Krad)	NIFA-95	Pb-91	Hassan-2k	Mean Dose Effect
10	68.3 _{ef}	78.17 _{cde}	92.2 _{ab}	79.58 _a
20	83.7 _{bcd}	65.9 _f	79 _{cde}	76.2 _a
30	85.1 _{bcd}	68.8 _{ef}	70.7 _{ef}	74.9 _a
40	83.1 _{bcd}	76.4 _{def}	76 _{def}	78.5 _a
Control	91 _{ab}	89 _{abc}	96.4 _a	
Mean Var.	82.38 _a	75.68 _a	82.9 _a	

LSD at 5% for means of percent pod damage by

Helicoverpa armigera = 12.17

LSD at 5% for Mean Dose Effects = 47.15

LSD at 5% for Mean Var. = 54.70

Means followed by same letters are not significantly different at 0.05% level of significance

recorded on NIFA-95 (10krad) (32.8) followed by Pb-91 (10krad) (32.4), Pb-91 (30krad) (31.1), NIFA-95 (20krad) (29.2) and Pb-91 (40krad) (29). The lowest size of *Helicoverpa armigera*'s population was found on Hassan-2k (40krad) (20), followed by Hassan-2k (30krad) (20.30), Hassan-2k (20krad) (22), Hassan-2k (10krad) (24.1), NIFA-95 (30krad) (25.6), NIFA-95 (40krad) (27.5), Pb-91-20 (28.7). According to these statistics the maximum

Table 9: Yield

Dose (Krad)	NIFA-95	Pb-91	Hassan-2k	Mean Dose Effect
10	3000 _{abcd}	2156 _e	2531 _{cde}	2562 _a
20	2625 _{abcde}	3156 _{abc}	3031 _{abc}	2937 _a
30	2562 _{bcd}	2562 _{bcd}	3437 _a	2854 _a
40	2937 _{abcde}	2187 _{de}	3375 _{ab}	2833 _a
Control	2379 _{cde}	2137 _e	2554 _{bcd}	2357 _a
Mean Var.	2701 _a	2440 _a	2986 _a	

LSD at 5% for yield of chickpea at different doses = 715

LSD at 5% for Mean Dose Effects = 5254

LSD at 5% for Mean Var. = 3291

Means followed by same letters are not significantly different at 0.05% level of significance

numbers of larvae were recorded on NIFA-95 (10krad) where as the minimum numbers were on Hassn-2k-40 krad. Dense larval population was observed on control than radiated genotypes.

Percent damage caused by *Helicoverpa armigera* on different Chickpea varieties treated by different radiation dosages:

Percent damage caused by *Helicoverpa armigera* was recorded on tested genotypes. This damage rate was quite different significantly ($P < 0.05$) (Table 8). The maximum damage was recorded on Hassan-2k (10krad) (92.2%), followed by NIFA-95 (30krad) (85.1%), NIFA-95 (20krad) (83.7%), NIFA-95 (40krad) (83.1%), Hassan-2k (20krad) (79%), Pb-91 (10krad) (78.2%) and Pb-91 (40krad) (76.4%). The lowest damage rate was recorded on Pb-91 (20krad) (65.9%), followed by NIFA-95 (10krad) (68.3%), Pb-91 (30krad) (68.8%), Hassan-2k (30krad) (70.7%) and Hassan-2k (40krad) (76%). Control in comparison to radiated genotypes was more affected by *Helicoverpa- armigera*.

Yield: Yield obtained at the end of season was remarkably different among genotypes as well as among doses with in a same cultivar. The highest yield was recorded from Hassa-2k (30 krad) (3437 kg ha⁻¹) followed by Hassan-2k (40 krad) (3375 kg ha⁻¹), Pb-91 (20 krad) (3156 kg ha⁻¹), Hassan-2k (20 krad) (3031 kg ha⁻¹), NIFA-95 (10 krad) (3000 kg ha⁻¹) and NIFA-95 (40 krad) (2937 kg ha⁻¹). Where as the lowest yield was recorded on Pb-91 (10 krad) (2156 kg ha⁻¹) followed by Pb-91 (40 krad) (2187 kg ha⁻¹), Hassan-2k (10 krad) (2531 kg ha⁻¹), NIFA-95 (30 krad) (2562 kg ha⁻¹), Pb-91 (30 krad) (2562 kg ha⁻¹) and NIFA-95 (20 krad) (2625 kg ha⁻¹). It showed that genotypes Hassan-2k (30 krad), Pb-91 (20 krad) and NIFA-95 (10 krad) obtained highest yield in respective varieties. Low yield was observed in control as compared to radiated genotypes.

Correlation of Trichomes and height with *Helicoverpa armigera*: Combine relationship of trichomes of chickpea and pod borer was found negative.

It means that as the number of trichomes goes high

the population of pod borer goes down. Same relationship was observed in case of height of chickpea plant and pod borer.

Response of different chickpea (*Cicer arietinum*) genotypes was studied against gram pod borer (*Helicoverpa armigera*) with relation to trichomes. The research was conducted in order to study the effect of leaf trichomes of radiated genotypes of *Cicer- arietinum* at different doses against *Helicoverpa armigera* in field. The effect of radiation upon the trichomes density, height of plant at different phenological stages of *Cicer- arietinum* and percent damage caused by *Helicoverpa armigera* were also studied.

Trichomes were studied on all genotypes and the results showed that radiation cause positive effect on number of trichomes. During studies of various stages of *Cicer arietinum* it has been cleared that Desi varieties (NIFA-95 and Pb-91) show late response towards the attaining high trichomes density on leaves. While Kabuli variety (Hassan-2k) gives positive early response at different phenological stages. The difference among these genotypes could be because of the difference of ability to mature early in season. Like wise non radiated genotypes have lesser number of trichomes than the radiated genotypes. These results are in fair agreement with those of^[4].

Heights of chickpea plants with respect to its different phenological stages were also studied. This study was carried out along the study of trichomes. It was observed that the genotypes radiated with high doses were found taller than the genotypes radiated with smaller doses. It was also showed in results that radiated plants remained short with respect to the non radiated plants. Although 40 krad produced the tallest one among the radiated genotypes but this was statistically lesser than the non radiated plants. The results are supported by Reddy *et al.*,^[5].

Larval population of *Helicoverpa armigera* has been studied at start of first egg laid in the field. Maximum number of larvae was observed on the genotypes radiated with small doses. This result satisfies the result of Bashir *et al.*,^[6]; they reported that trichomes have negative effect on *Helicoverpa armigera*'s development and life cycle. It means higher the number of trichome s on leaves lesser the development of *Helicoverpa- armigera*. Genotypes which have been treated with high dose of radiation produced high number of trichomes there fore; they got less population of *Helicoverpa armigera*. While those genotypes which has been treated with less dose of radiation got less number of leaf trichomes there fore, they faced high population of *Helicoverpa armigera*'s larvae. This is due to the fact that trichomes of chickpea contain

malic acid and oxalic acid. Although malic acid stimulates the oviposition behavior of *Helicoverpa armigera*, but this happens only at vegetative stage of plant and after flowering stage it discourages this behavior. On the other hand oxalic acids do have an antibiotic effect for the larvae of *Helicoverpa armigera* at early as well as at lateral stages. As radiation produces more trichomes there fore, high radiation dose cause high antibiotic as well high antixenotic effect.

After maturation of pods the percent pod damage has been observed. In this session maximum percent damage has been observed on Hassan-2k (10krad) (92.2%). In case of NIFA-95 the number of trichomes at podding stage was not significantly different, there fore, the attack of *Helicoverpa armigera* did not show abrupt change with the change of dose rate. But in pod damage it has given a clear picture that NIFA-95 (10krad) got less damage than others. Same in case of second variety Pb-91 (20krad) showed the lowest percent damage and in third variety Hssan-2k (30krad) observed the lowest mark as compare to its respective genotypes.

At the end of the season total yield has been obtained. It was obvious that those genotypes who suffered maximum pod damage showed minimum yield. On the other hand those which had minimum pod damage obtained maximum yield. Trichomes and height of chickpea showed negative correlation with the population of *Helicoverpa armigera*. This result satisfies the findings of Bashir *et al.*,^[6]. They also reported the negative relationship between trichomes and *Helicoverpa armigera*.

By collecting all observations of all phenological stages it can be concluded that radiation causes good positive linear growth in number of trichomes. Similarly radiation cause dwarfness in the genotypes as compared to non radiated genotypes. High doses, in all varieties, have higher number of trichomes and lower larval population but they got higher percent pod damage.

From all these studies it has been concluded that among all the 12 genotypes Pb-91 (20krad) has the ability to tolerate the attack of *Helicoverpa armigera*. There fore, this genotype is recommended for cultivation. While NIFA-95 (10krad) and Hassan-2k (30krad) are tolerant and recommended for cultivation.

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