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Evaluation of Gamma Irradiation on Cotton Genotypes Fruiting Parts and Infestation of Spotted Bollworm, *Earias Vittella* (Fab.)

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Abstract: Research trial was carried out in the fields of Agriculture Research Institute, Tandojam during 2008 and 2009. The effects of gamma ("Gy" 150, 200 and 250) were evaluated on six cotton genotypes i.e. St-7, BNT, B-3, SB, SP and B-4. The data were recorded on mean number of fruiting bodies; squares, flowers, green bolls setting and spotted bollworm damage percent on square, flowers and green bolls. Results revealed that the gamma irradiated genotypes were significantly effective when compared to untreated cotton genotypes. The highest mean number of squares was found in mutant genotype SP* (200 Gy) and (250 Gy), during both years. The maximum mean number of flowers was observed in B-4* and SP*, with (200 Gy) during 2008 and 2009. In the year 2008 higher mean numbers of green bolls were found in B-4* with (150 Gy) and BNT with (250 Gy). While in year 2009 B-4* (150 Gy) and BNT with (250 Gy). The comparative infestation of spotted bollworms *E. vittella* on squares, flowers and green bolls in cotton genotypes indicated high resistance, moderate susceptibility and high susceptibility in untreated and gamma irradiated strains during above of mentioned period. Results showed that there were significant differences between untreated parent and their gamma irradiated cotton genotypes bearing fruiting bodies and pest infestation.

Keywords: Gamma radiation, cotton, resistance, susceptible, spotted bollworm

1. INTRODUCTION

Cotton (*Gossypium hirsutum* L.) is dominant fibrous crop maintains individual position in agriculture of Pakistan. Cotton plays a pivotal role as an agricultural, industrial, commercial product and essential food source for human and animal (Hajatmand, *et al*. 2014). Cotton crop is most favorable food for insects and the damages in the yield of crop caused by insect is estimated at about 30-40% (Haque, 1991). Bollworm complex caused 25-30% damages in yield of cotton seed**,** while the *E. vittella* was found as severe pest in cotton triggering 19-20% damage (Kamaluddin, 1994). (Chang *et al*., 2002) evaluated different cotton genotypes and varieties against bollworms and who find out damage range between 3.8 to 12.6%. (Pathan *et al*., 2007) estimated damage percent of bollworm complex and calculated damage caused by bollworms from 12.61 to 19.2% on different cotton varieties. Population of *Earias* spp. and their infestation attain up to 11-12 % during the month of August and September (Shah *et al.*, 2011).For decreasing insect damage and increasing crop yield growers frequently were applying insecticides. Generally farmers were confidently applying insecticides to control insects (Soomro, *et al*., 2000). Applications of insecticides are gradually increased since last 20 years in Pakistan, 80 percent total stock of country applied on a single cotton crop (Tariq, 2000). It is calculated approximately 70-90% insecticides of multinational and national insecticides companies were applied on cotton crop in Pakistan (Eavy, *et al*., 1995; Chaudhry, 1995 and Yousaf, *et al*., 2004). Pakistan had imported insecticides cost of Rs. 8.138 billion during, 2003 (Khooharo, *et al*., 2008). The Bt cotton provide circumstance to cover the bollworms problem and increase production profits to farmers community (Manjunatha, *et al*., 2009). Whereas, Sharma and Pampapathy (2006) reported bollworm cause lowest damage in Bt cotton varieties, while highest damage recorded in non-Bt cotton varieties. While Sarfraz, *et al*., (2005) found *E. vittella* was considerably triggered highest damage on squares, flowers and green bolls of conventional variety FH-900 compare to IRFH-901 transgenic cotton variety. The excess use of pesticides caused health problem and environmental pollution hazards in the country; the Integrated Pest Management (IPM) practices inspire to reduce usage of pesticides and pest population below economic injury level (Khooharo, *et al*., 2006). Host plant resistance is a major part of an IPM programme; the resistant plant is least suitable for the pest colonization due to scarcity of qualitative food. The plant breeder improves the high yielding potential varieties through traditional, transgenic and mutation techniques. There is a high potential of mutational radio treatments for the development of cotton plant characteristics for growth in agriculture (Alam, *et al.,* 2004). The appropriable applications of gamma dosage could be accomplished magnificently in distinguishing physiological features (Kiong, *et al*., 2008). Whereas, (Haq, 2009) reported that the mutation breeding involves the use of induced

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beneficial changes for practical plant breeding purposes for both directly as well as indirectly. A radiation technology is used to create changes in the plant characteristics for development a new progeny (Piri, *et al.,* 2011). Since last three decades there are more than 3200 crops have been improved through radio mutagens (FAO/IAEA, 2012). Pakistan cotton grower earn annually approximately US$ 20m from mutant single cotton variety Niab-78 (Ahloowalia, *et al.,* 2004). The objectives of this study are to find out yield potential and host plant resistance in cotton genotypes against *E. vittella* through cotton seed mutation techniques.

2. MATERIALS AND METHODS

The representative seeds of six parent cotton genotypes viz; St-7, BNT, B-3, SB, SP & B-4 were irradiated (150, 200, and 250 Grays "Gy") and the result of new mutagenic genotypes viz St-7*, BNT*, B-3*, SB*, SP* & B-4* were totaled twenty four genotypes studied at Cotton Research Section, Agriculture Research Institute, Tandojam Sindh, Pakistan during 2008-09. Earlier then the parents were treated from a Cobalt-60,^{60}Co source at the Nuclear Institute of Agriculture and Biology (NIAB), Faisalabad. The experiment was laid out in randomized complete block design (RCBD) with four replications. The effects for setting fruiting parts and relative resistance of untreated (parent) and gamma irradiated cotton genotypes against spotted bollworm were studied on M4 & M5 generations.

The statistical analysis using general ANOVA was followed by Least Significant Difference (LSD) at 0.05% probability level. The data for significant difference in square, flower, green bolls and damage percent of *E. vittella* evaluated through a multiple comparison test using statistix software 8.1.

3. RESULTS

Mean Number of Square

The results in **(Table 1-2)** the mean number of square on different genotypes varied significantly (F=12.57; df=5; P< 0.0000) among different genotypes based on the general analysis of variance. The maximum square formation was observed in SP* (200 Gy) followed by untreated genotype B-3 and SP* (250 Gy) during-2008. While significantly (F=4.34; df=5; P< 0.0006) maximum square calculated in *SP (200 Gy), SP* (250 Gy) and untreated SP genotype during-2009. Whereas, minimum number of square found in SB* (250 Gy) followed by B-3* (250 Gy) and SP* (150 Gy) during-2008 and SB* (200 Gy) followed by SB* (250 Gy) and SP* (150 Gy) respectively during-2009.

Tabel-1: Mean number of Square in Parent and Gamma Irradiated Cotton Genotypes during-2008

Cotton Genotypes	Parents	Gamma Rays doses (Gy)		
		150 Gy	200 Gy	250 Gy
St-7	21.409 d	21.353 de	19.547 i	20.1 gh
BNT	21.359 de	20.721 f	21.262 de	21.315 de
B-3	23.306 a	21.088 e	20.335 g	18.938 j
SB	22.379 c	21.485 d	19.856 hi	19.138 j
SP	22.503 c	15.009 k	23.306 a	22.979 b
B-4	20.071 gh	22.532 c	21.397 de	19.812 hi

Means followed by same letters are significantly different from each other, (LSD; P=0.05)

Tabel-2: Mean number of Square in Parent and Gamma Irradiated Cotton Genotypes during-2009

Cotton Genotypes	Parents	Gamma Rays doses (Gy)		
		150 Gy	200 Gy	250 Gy
St-7	20.456 defgh	20.65 defg	19.609 fghi	19.594 fghi
BNT	20.097 efgh	20.462 defgh	20.962 def	19.785 fghi
B-3	22.932 ab	21.524 cd	19.465 ghi	19.497 ghi
SB	21.229 de	20.338 defgh	19.129 hi	18.512 i
SP	22.668 abc	14.676 j	23.818 a	23.709 a
B-4	19.909 efgh	21.641 bcd	21.2 de	19.744 fghi

Means followed by same letters are significantly different from each other, (LSD; P=0.05)

Mean Number of Flower

The result in **(Table 3-4)** revealed that the maximum mean number of flowers was significantly (F=14.58; df=5; P< 0.0000) found in B-4* treated with 200 Gy followed by SB* and SP* (200 Gy) respectively during-2008, while significantly (F=2.01; df=5; P< 0.0000) B-4* (200 Gy) followed by untreated genotype B-3 and SP* (200 Gy) during-2009 respectively. Whereas the minimum mean number of flowers recorded in BNT* (150 Gy), untreated genotype SP and St-7* (150 Gy) during-2008 and in 2009 on BNT* (150 Gy) followed by St-7* (150 Gy) and B-3* (200 Gy).

Table-3: ***Mean number of Flowers in Parent and Gamma Irradiated Cotton Genotypes during-2008***

Cotton Genotypes	Parents	Gamma Rays doses (Gy)		
		150 Gy	200 Gy	250 Gy
St-7	1.632 ijkl	1.556 l	1.659 ghijk	1.724 efgh
BNT	1.659 ghijk	1.609 jkl	1.674 ghijk	1.729 defg
B-3	1.788 bcdef	1.665 ghijk	1.694 ghij	1.715 fghi
SB	1.741 cdefg	1.806 bcde	1.862 b	1.721 efgh
SP	1.606 kl	1.712 fghi	1.821 bc	1.703 fghi
B-4	1.741 cdefg	1.812 bcd	1.985 a	1.641 hijkl

Means followed by same letters are significantly different from each other, (LSD; P=0.05)

Table-4: Mean number of Flowers in Parent and Gamma Irradiated Cotton Genotypes during-2009

Cotton Genotypes	Parents	Gamma Rays doses (Gy)		
		150 Gy	200 Gy	250 Gy
St-7	1.788 bcd	1.665 ef	1.741 cde	1.688 ef
BNT	1.735 cde	1.626 f	1.727 cde	1.744 cde
B-3	1.909 a	1.677 ef	1.668 ef	1.794 bc
SB	1.788 bcd	1.803 bc	1.732 cde	1.735 cde
SP	1.697 def	1.724 cde	1.853 ab	1.688 ef
B-4	1.732 cde	1.735 cde	1.912 a	1.677 ef

Means followed by same letters are significantly different from each other, (LSD; P=0.05)

Mean Number of Green Bolls

The results in **(Table-5-6)** showed that significantly (F=587.49; df=5; P< 0.0000) maximum mean number of green bolls observed in B-4* treated with 150 Gy followed by untreated genotype B-4, B-4* (200 Gy) and BNT* (250 Gy) respectively during 2008. Whereas, significantly (F=61.29; df=5; P< 0.0000) maximum mean number of green bolls in B-4* (150 Gy) followed by BNT* (250 Gy), untreated B-4 and B-4* (200 Gy) was recorded during-2009. While, there were significantly minimum mean number of green bolls recorded in St-7* (150 Gy) followed by SP* (150 Gy), SB* (250 Gy) and untreated genotype St-7 respectively during both crop growing sessions.

Table-5: Mean number of Bolls in Parent and Gamma Irradiated Cotton Genotypes during-2008

Cotton Genotypes	Parents	Gamma Rays doses (Gy)		
		150 Gy	200 Gy	250 Gy
St-7	15.709 n	17.544 l	19.238 e	18.415 ij
BNT	18.394 ij	18.318 ij	18.785 fg	20.138 c
B-3	19.859 d	18.059 k	18.968 f	18.494 hi
SB	18.679 gh	18.021 k	18.247 jk	17.032 m
SP	20.056 cd	17.25 m	18.853 fg	19.397 e
B-4	20.409 b	22.765 a	20.138 c	19.203 e

Means followed by same letters are significantly different from each other, (LSD; P=0.05)

Table-6: Mean number of Bolls in Parent and Gamma Irradiated Cotton Genotypes during-2009

		Gamma Rays doses (Gy)		
Cotton Genotypes	Parents	150 Gy	200 Gy	250 Gy
St-7	15.662 j	17.753 hi	19.715 d	18.932 f
BNT	18.888 f	18.794 fg	18.829 fg	20.794 b
B-3	19.612 de	18.382 fgh	18.976 ef	18.662 fg
SB	18.897 f	18.191 gh	18.803 fg	17.524 i
SP	20.679 b	17.524 i	18.768 fg	19.762 cd
B-4	20.397 bc	22.194 a	20.265 bcd	19.912 cd

Means followed by same letters are significantly different from each other, (LSD; P=0.05)

During present studies, it was observed that some of the mutant genotypes developed different agronomical characters. The mean comparison was assembled on LSD (0.05), all values showed significantly difference for bearing fruiting bodies. Table1-6 showed significantly different performance amongst different gamma dosage 150, 200 and 250 Gy for setting square, flower and green bolls. However, maximum number of square and flowers was found in mutant genotypes SP* (200 Gy) and B-4* (200 Gy) respectively. While, there were maximum green boll formation was recorded in B-4* (150 Gy) and untreated genotypes B-3. These results confirmed that gamma-rays can change the square, flowers and bolls bearing performance of plants. These results agreements with those of Ugorji *et al.*, (2012) evaluated effect of gamma irradiated 200 Gy on pigeon pea and cowpea. He explained that pigeon pea plants decreased 50% flowers and cowpea increased flower, pods and seeds. Efe, *et al.*, (2013) reported that number of bolls per plant support the elementary part for seed cotton yield. The highest boll setting was recorded in mutant varieties as compared to standard varieties. This conformity is also partial in agreement with those of Amin *et al.*, (2008), Ahmed, *et al.*, (2008), Makhdoom *et al.*, (2010) and Yahaya, *et al.*, (2012) who reported maximum number of bolls increased seed cotton yield form genetically modified strains than conventional strains.

Damage Percent of E. vittella on Square and Flowers

On the basis of mean seasonal damage percent of immature fruiting parts (square and flowers) combine, in all three gamma irradiated dosage mutant genotypes was significantly difference form untreated (parent) genotypes against *E. vittella* resistance and susceptibility during 2008 and 2009. The data presented in **(Table 7-8)** indicate that maximum damage percent of square and flowers observed in mutant genotype B-3* treated with 250 Gy showed significantly (F=229.62; df=5; P< 0.0000) highly susceptible genotype followed by B-3* (200 Gy), St-7* (200 Gy), BNT* (200 Gy), B-4* (150 Gy) and untreated genotype B-3 respectively during-2008. Similarly in B-3* irradiated with 250 Gy found significantly (F=109.91; df=5; P< 0.0000) highly susceptibility followed by B-3* (200 Gy), St-7* (200 Gy), BNT* (200 Gy), SB* (250 Gy), B-4* (250 Gy) and B-4* (150 Gy) respectively during 2009.

The B-4* (250 Gy) was found significant moderately susceptibility followed by untreated genotype B-4, SB* (250 Gy), BNT* (150 Gy), untreated genotype St-7, SB* (200 Gy), untreated genotype BNT, untreated genotype SB, SP* (200 Gy), SB* (150 Gy) and untreated genotype SP respectively during-2008. However, the significantly moderately susceptibility recorded during-2009 in untreated genotype B-4 followed by untreated genotype B-3, untreated genotype St-7, SB* (200 Gy), BNT* (150 Gy), untreated genotype SB, untreated genotype BNT, SB* (150 Gy), SP* (200 Gy) and untreated genotype SP respectively.

The significantly highly resistance found in mutant genotype B-3* (150 Gy) followed by B-4* (200 Gy), BNT* 250 Gy, St-7* (250 Gy), St-7* (150 Gy), SP* (150 Gy) and SP* (250 Gy) respectively during-2008. Mutant genotype BNT* (250 Gy) was significantly highly resistance followed by SP* (150 Gy), St-7* (150 Gy), B-4* (200 Gy), B-3* (150 Gy), St-7* (250 Gy) and SP* (250 Gy) respectively during-2009.

Table-7: Mean damage percent of *E. vittella* on square and flowers in untreated and gamma irradiated cotton genotypes during-2008

Cotton Genotypes	Parents	Gamma Rays doses (Gy)		
		150 Gy	**200 Gy**	**250 Gy**
St-7	9.138 g	4.29 kl	12.8 c	4.355 kl
BNT	7.257 hi	9.176 g	11.576 d	4.462 kl
B-3	10.313 ef	4.935 jk	14.634 b	18.795 a
SB	6.782 i	5.442 j	7.965 h	9.364 g
SP	5.366 j	3.728 l	6.697 i	3.718 l
B-4	9.65 fg	10.668 e	4.789 jk	9.899 efg

Means followed by same letters are significantly different from each other, (LSD; P=0.05)

Table-8: Mean damage percent of *E. vittella*on square and flowers in untreated and gamma irradiated cotton genotypes *during-2009*

Cotton Genotypes	Parents	Gamma Rays doses (Gy)		
		150 Gy	**200 Gy**	**250 Gy**
St-7	9.362 de	4.712 i	13.197 a	4.323 i
BNT	7.044 g	8.756 ef	11.144 b	4.826 i
B-3	9.645 de	4.608 i	13.571 a	14.068 a
SB	8.216 f	6.06 h	9.027 ef	10.886 bc
SP	5.14 hi	4.772 i	5.803 h	4.305 i
B-4	9.649 de	10.051 cd	4.647 i	10.7 bc

Means followed by same letters are significantly different from each other, (LSD; P=0.05)

Damage Percent of E. vittella on Green Bolls

Means comparison of damage percent data presented in **(Table 9-10)** showed different response of *E. vittella* damage on green bolls on parent (untreated) and their three dosages of gamma irradiated cotton genotypes revealed highly significant difference between untreated and treated genotypes during-2008 and 2009. The data were indicated significantly (F=37.50; df=5; P< 0.0000) and (F=47.79; df=5; P< 0.0000) maximum damage percent of *E. vittella* on mutant genotype B-3* irradiated with 250 Gy found comparatively highly susceptible followed by untreated genotype St-7, B-3* (200 Gy), St-7* (200 Gy), SB* (250 Gy), BNT* (200 Gy) during-2008 and 2009 respectively.

Whereas, the moderately bollworm damage percent was observed in untreated genotype B-4 followed by untreated genotype B-3, untreated genotype BNT, B-4* (150 Gy), B-4* (250 Gy), SB* (200 Gy), BNT* (150 Gy), untreated genotype SB, SP* (200 Gy), untreated genotype SP and SB* (150 Gy) during both crop growing sessions.

However, there was no significant difference found in damage percent amongst the gamma irradiated cotton genotypes and observed highly resistance against *E. vittella* viz; mutant genotype B-4* (200 Gy) followed by St-7* (250 Gy), SP* (250 Gy) St-7* (150 Gy), B-3* (150 Gy), BNT* (250 Gy) and SP* (150 Gy) accordingly during-2008 and 2009.

Table-9: Mean damage percent of *E. vittella* on green bolls in untreated and gamma irradiated cotton genotypes *during-2008*

Cotton Genotypes	Parents	Gamma Rays doses (Gy)		
		150 Gy	**200 Gy**	**250 Gy**
St-7	12.845 b	4.875 jk	11.68 bc	4.991 jk
BNT	9.008 ef	7.691 fghi	11.027 cd	4.596 k
B-3	9.191 ef	4.614 k	12.37 bc	16.68 a
SB	7.033 ghi	6.215 ij	7.894 fgh	11.196 cd
SP	6.349 hij	3.449 k	6.38 hij	4.903 jk
B-4	9.858 de	8.674 ef	4.96 jk	8.479 efg

Means followed by same letters are significantly different from each other, (LSD; P=0.05)

Table-10: Mean damage percent of *E. vittella* on green bolls in untreated and gamma irradiated cotton genotypes during-2009

Cotton Genotypes	Parents	Gamma Rays doses (Gy)		
		150 Gy	**200 Gy**	**250 Gy**
St-7	14.087 b	4.773 hi	11.526 cd	4.845 hi
BNT	8.143 f	7.763 f	10.576 d	4.549 ij
B-3	8.81 ef	4.726 hi	12.788 bc	17.0 a
SB	7.325 fg	5.894 ghi	7.908 f	11.409 cd
SP	5.907 ghi	3.19 j	6.19 gh	4.97 hi
B-4	10.254 de	8.221 f	4.918 hi	8.432 f

Means followed by same letters are significantly different from each other, (LSD; P=0.05)

The results in **(Tables 7-10)** showed obviously significant effect of gamma irradiation on the relative resistance of parent (untreated) and gamma irradiated cotton genotypes against *E. vittella* infestation on square, flower and green bolls. Mutant genotypes St-7*, B-3*, and SP* (150 Gy), B-4* (200 Gy) and St-7*, B-3* and SP* treated with 250 Gy was recorded tolerance against *E. vittella*. These results in relation to damage percent of *E. vittella* on different untreated and mutant genotypes are in agreement with those of Pathan, *et al.*, (2007), Rehman, *et al*., (2001) they reported that mutant cotton variety NIAB-78 proved highly in seed cotton yield and moderately susceptible against *E. vittella*. The present results findings on damage percent of *E. vittella* on square, flower and green bolls are partially conformed to Ahmed *et al*., (2012); Jamshed, *et al.*, (2008); Sarfraz, *et al*., (2005) and Aslam, *et al.*,(2004) reported that *E. vittella* caused minimum damage on Bt cotton varieties, while maximum damage on non-Bt conventional cotton varieties.

4. CONCLUSIONS

It is known that the purpose of this study ultimately to compare the performance of parent and gamma irradiated cotton genotypes in bearing fruiting bodies and resistance development against spotted bollworm. It is evident that irradiated 150 Gy and 250 Gy dosages cotton genotypes develop highest bolls setting and built resistance against spotted bollworm. The increasing resistances in cotton genotypes ultimately reduce the usage of insecticides application on cotton crop for suppressing pest pressure.

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