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Effects of gamma radiations on some morphological and biochemical characteristics of *Brassica napus* L. (variety Altex)

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Abstract

In the present study, the variability caused by gamma rays in qualitative and quantitative traits comprising days to germination, days to flowering, plant height, number of branches/plant, number of siliqua/plant, number of leaves/plant, number of seeds/siliqua, siliqua length, 1000-seed weight, oil, Glucosinulate, moisture, proteins, oleic acid, linolenic acid and erucic acid contents were investigated. Seeds of *Brassica napus* L. (variety Altex) were treated with 10, 15, 20, 25 and 30 Krad doses of gamma rays. The results showed that days to germination and days to flowering were delayed (8 and 67 days respectively) in higher doses compared to control (5 and 66 days respectively). Higher doses of radiation decreased plant height (79.55 cm), number of branches/plant (7), number of siliqua/plant (120) and number of leaves/plant (10) compared to control (108.20 cm, 5.8, 174 and 12.2 respectively). An increase was noticed for number of seeds/siliqua (19.8) and siliqua length (4.84 cm) with higher doses of radiations compared to control (17.6 and 4.68 cm respectively). A significant decrease was noticed in oil percentage (35.53%), Glucosinulate contents (128.13 µmol/g), moisture percentage (4.53%), Linolenic acid percentage (11.30%) and Erucic acid percentage (49.83%) compared to control (37.07%, 133.20 µmol/g, 4.76%, 11.83% and 53.10% respectively). A significant increase was noticed in proteins (32.03%) and oleic acid (34.80%) contents as compared to control (30.70% and 31.86% respectively).

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Introduction

Brassica napus (Rapeseed), also known as rape, oilseed rape, rapa, rapeseed is a bright yellow flowering member of the family Cruciferae. The family is cosmopolitan in nature but the major centers of diversity are southwestern and central Asia and Mediterranean region. Rapeseed (*Brassica rapa* and *B. napus*) and mustard (*B. juncea*) are the important crop of *Brassica* group grown as oilseed crops in Pakistan. These have remained one of the major sources of oil in the sub-continent and worldwide for centuries. Rapeseed and mustard are rich source of oil and contains 44-46% good quality oil. In addition, its meal has 38-40% proteins that have a complete profile of amino acids including lysine, methionine and cysteine. Its oil contain a very low amount of saturated fatty acids (7 %) along with Cholesterol lowering monounsaturated and polyunsaturated fatty acids which are the main constituents of canola oil (MacDonald., 2011 and Emrani *et al.,* 2012). Rapeseed is the second leading source of vegetable oil worldwide, after soybean in the global oil-seed crop production surpassing peanut, sunflower and cottonseed during the last two decades (Anonymous., 1999, Kauser *et al.,* 2006, Tohidi-Moghadam *et al.,* 2009, Shah and Rahman., 2009, Anon., 2007, Emrani *et al.,* 2012). Gustaffson *et al.,* (1971) developed a high yielding variety of Barley having high protein contents. Khatri *et al.,* (2005) got three high yielding and early maturing mutants varieties via combined effects of physical (gamma rays) and chemical mutagens (EMS) on the seeds of *Brassica juncea* L.cv.S-9. Shah *et al.,* (2001) developed a new oilseed *Brassica napus* L.cv ABASIN-95 by induced mutations using Gamma rays. The new variety was high yielding and resistant to fungal pathogens. The present study is also carried out to study the induced mutations and the effects of physical mutagen (Gamma Radiation) on the qualitative and quantitative characters of *Brassica napus* L.

Material and methods

Plant Material

Seeds of *Brassica napus* L. variety Altex 37 were selected for radiation.

Gamma Irradiation

Seeds of *Brassica napus* L. variety Altex 37 were irradiated at Nuclear Institute for Food and Agriculture (NIFA) Peshawar, Pakistan via $Cobalt^{60}$ radiation source. The total doses of irradiated seeds were 0, 10, 15, 20, 25 and 30 K Rad.

Sowing

The seeds were sown in the Botanical Garden, Islamia College Peshawar in october 2012. Irradiated seeds of each dose were sown in 5 replica pots covered with plastic. Various growth stages of plant from germination to harvest were noted timely.

Characters

Various agronomic and morphological characters were measured during the plant's life
span. It includes the following:

1. Days to Germination.
2. Days to Flowering.
3. Plant Height.
4. Number of Branches/Plant.
5. Number of Siliqua/Plant.
6. Number of Seeds/Siliqua.
7. Number of Leaves/Plant.
8. Siliqua Length.
9. 1000 Seed weight.

Results and discussion

Mutations are changes in a genomic sequence and can be defined as sudden and spontaneous heritable changes in the cell's genetic material at chromosome or gene level. Mutations are caused by radiation, viruses, transposons and mutagenic chemicals, as well as errors that occur during meiosis or DNA replication.The parameters studied are given below:

Plant Height

The results show a decreasing tendency in the mean values of plant height with higher doses of radiation i.e., 15 Krad (98.55 cm), 20 Krad (89.66 cm), 25 Krad (89.15 cm) and 30 Krad (79.55 cm) as compared to control (108.2 cm). An increase was noticed in 10

Krad (114.55 cm) as compared to control and other doses. In higher doses i.e., 25 Krad and 30 Krad a significant decrease in plant height was found (89.15 cm and 79.55 cm respectively) and short statured plants are produced (Table and Graph 1). The reduction in plant height can be attributed to reduction in mitotic activity of meristematic tissues and reduced moisture content in seeds as reported by Khalil *et al.,* 1986. Similary, Norfadzrin *et al.,* 2007 noticed that higher gamma ray doses (600 and 800 Gy) had negative effect on the morphological characteristics of tomato and okra seedlings derived from irradiated seeds. A reduction in plant height and number of branches for many crops that were exposed to higher gamma ray doses had already been reported by Thimmaiah *et al.,* 1998, Muhammad and Afsari,2001, Al-Salhi *et al.,* 2004, Yaqoob and Ahmad, 2003, Token *et al.,* 2005 and Kon *et al.,* 2007 (Table and Graph 1).

Table 1. Morphological parameters of *Brassica napus* affected by different doses of gamma radiations.

Treatments	Plant height (cm)	Number of branches/plant	Number of siliqua/plant	Number of Seeds/Siliqua	Number of Leaves/Plant	Siliqua Length(cm)
Control	108.20 ab	5.8 a	174.0 ab	17.6 ab	12.2 a	4.68 ab
10 Krad	114.55 a	7.0 a	187.0 a	17.0 ab	11.4 ab	4.76 ab
15 Krad	98.55 abc	6.6 a	143.0 ab	19.2 a	10.0 ab	5.04 a
20 Krad	89.66 bc	6.0 a	112.6 b	14.6 b	9.6 b	4.12 c
25 Krad	89.15 bc	7.0 a	121.0 b	15.6 ab	9.4 b	4.48 bc
30 Krad	79.55 c	5.6 a	119.6 b	19.8 a	9.4 b	4.84 ab
LSD at 0.05 α level	20.813	2.276	61.713	4.426	2.467	0.553

Number of Branches/Plant

The data of table 1 also shows the effects of Gamma Radiation on number of Branches/Plant. The highest number of Branches/Plant were noticed in 10 Krad (7 Branches/Plant) and 25 Krad (7 Branches/Plant). The lowest value for number of Branches/Plant was noticed in 30 Krad (5.6 Branches/Plant). The results confirmed the findings of Thimmaiah *et al.,* 1998, Muhammad and Afsari, 2001 and Dakshnamoorthy *et al.* (2010) (Table and Graph 1).

Table 2. Effects of various doses of gamma radiations on the qualitative analysis of seeds.

Treatments	Oil %	Protein%	Glucosinulate µmol/g	Moisture%	Oleic Acid (18:01) %	Linolenic Acid (18:03) %	Erucic Acid (22:01) %
Control	37.07b	30.70 d	133.20 b	4.76 b	31.86 c	11.83 a	53.10 a
10 Krad	38.07a	29.66 e	127.03 c	4.93 a	32.10 c	11.56 b	51.76 b
15 Krad	35.90d	30.93 c	123.90 d	4.46 c	34.50 a	11.10 d	50.66 cd
20 Krad	36.60c	30.80 d	126.96 c	4.56 c	32.90 bc	11.93 a	51.53 bc
25 Krad	36.47c	31.30 b	138.13 a	4.16 d	33.86 ab	11.53 b	51.56 bc
30 Krad	35.53e	32.03 a	128.13 c	4.53 c	34.80 a	11.30 c	49.83 d
LSD at 0.05 α level	0.198	0.113	1.406	0.127	1.177	0.187	0.985

Number of Siliqua/Plant

The results for Number of Siliqua/Plant showed a decrease in the mean values for number of siliqua/plant with increasing doses of Gamma radiations i.e., 15 Krad (143 siliqua/plant), 20 Krad (112.6 siliqua/plant), 25 Krad (121 siliqua/plant) and 30 Krad (119.6 siliqua/plant) compared to control (174 siliqua/plant). An increase is noticed in 10 Krad (187 siliqua/plant) compared to control (174 siliqua/plant) and other doses (Table and Graph 1).

Number of Seeds/Siliqua

Variation was noticed in mean values of Number of Seeds/Siliqua for various doses. 30 Krad showed the

highest mean values for Number of Seeds/Siliqua (19.8 seeds/siliqua). The stimulatory effect of 30 Krad dose is due to the fact that mutagens stimulate the role of enzyme and growth hormones responsible for growth and yield of seeds. Increased number of fruit/ plant and seeds/siliqua as a result of gamma irradiation was recorded by (Dubey *et al.,* 2007, Mishra *et al.,* 2007; Sharma and Mishra, 2007; Sujaya-Das *et al.,* 2007 and Sundaravadivelu *et al.,* 2006). 20 Krad and 25 Krad have mean values for seeds/siliqua as 14.6 and 15.6 respectively. 0, 10 and 15 Krad showed mean values for number of seeds/siliqua 17.6, 17 and 19.2 respectively (Table and Graph 1).

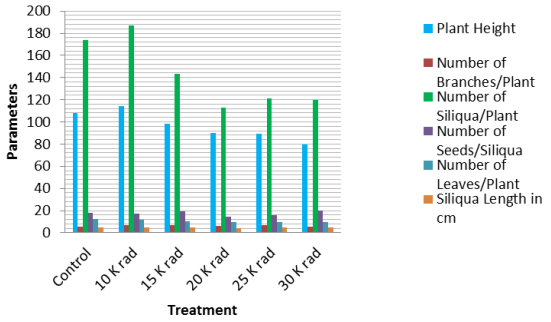

Fig. 1.

Number of leaves/plant

Control showed the highest value for the mean of number of leaves/plant (12.2). For all other doses a decreasing tendency in the mean values of number of leaves/plant was noticed i.e., 10 Krad (11.4), 15 Krad (10), 20 Krad (9.6), 25 Krad (9.4) and 30 Krad (9.4) which confirms the findings of Yaqoob and Ahmad (2003) in mungbean (Table and Graph 1).

Siliqua length

It showed a varying tendency for various doses. Control, 15 Krad and 30 Krad gave the highest mean values for siliqua length (4.68, 5.04 and 4.84 cm respectively). For 10 Krad and 25 Krad, the mean values for siliqua length were 4.76 cm and 4.48 cm while 20 Krad showed 4.12 cm, which was the lowest value for all the doses (Table and Graph 1).

Chemical Analysis of Seeds

The qualitative analysis of seeds was carried out using NIRS (Near Infra-Red Reflectance Spectroscopy) which works on the principle of measuring the absorption of light energy or wavelengths of each component at its characteristic frequency in the near IR region.

Oil Percentage

The *Brassica napus* seeds irradiated with gamma rays were analyzed for oil contents and the data revealed that the oil contents decreased significantly with increasing radiation doses. The lowest oil contents (35.53 %) were recorded for 30 Krad dose. It confirms the findings of Lutf Ullah *et al.* (2003) (Table and Graph 2).

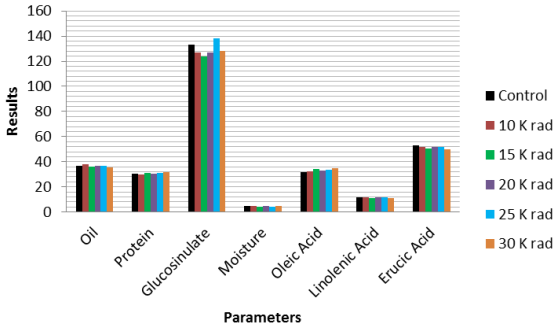

Fig. 2.

Protein Percentage

The gamma irradiated seeds were analyzed for protein contents compared to control. The results showed that the Protein contents for the higher radiation doses *i.e.* 25 Krad and 30 Krad were increased (31.30 % and 32.03 % respectively) as compared to control (Table and Graph 2).

Glucosinulate (GSL) Contents

The irradiated seeds were analyzed for GSL contents. The results revealed that with increasing doses of gamma rays, the GSL contents were significantly decreased except with the 25 Krad dose which showed a deviation and an increase in GSL contents (Table and Graph 2).

Moisture

The irradiated seeds were analyzed for moisture contents. The results showed that with increasing radiation doses the moisture contents of the seeds decreased significantly compared to control except with the 10 Krad which showed higher mean value for

moisture compared to control. The values of the equilibrium moisture contents decreased with increasing radiation doses (Wang and Yu; 2007) (Table and Graph 2).

Oleic Acid (18: 01; 09) Contents

The analysis of irradiated seeds compared to control revealed that the oleic acid contents significantly increased with the increasing doses of gamma rays. Higher doses *i.e.* 25 Krad and 30 Krad showed an increase (33.87 % and 34.80 % respectively). The oleic acid contents compared to control (31.87 %). Higher radiation doses increased oil content in different degrees, the oleic acid and erucic acid contents showed a drastic variation (Guang yaol *et al.,* 2007) (Table and Graph 2).

Linolenic Acid (18: 03; 9, 12, 15) Contents

The analysis of irradiated seeds compared to control revealed that the Linolenic acid contents changed variously compared to control. 20 Krad gave the highest mean value (11.93 %), while 15 Krad gave the lowest mean value (11.10 %). Control, 10 Krad, 25 Krad and 30 Krad showed 11.83 %, 11.57 %, 11.53 % and 11.30 % respectively (Table and Graph 2).

Erucic Acid (22: 01) Contents

Erucic Acid contents decreased significantly in the irradiated seeds with increasing doses of gamma rays. The highest mean value for Erucic acid (53.10 %) was found in control and the lowest (49.83 %) was found in the highest radiation dose i.e., 30 Krad. An increase in Erucic acid and Oleic acid contents were also found by Guang yaol *et al.,* (2007). (Table and Graph 2).

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