CONCLUSIONS
6.1 Mitotic chromosomal aberration

6.1.1 Prophase aberration

1. In *A. cepa* prophase aberration induced by laser exposures at 514 nm was maximum.

2. Prophase aberration induced by UV and Hydroxyl amine were lower than 514 nm and similar to 476 nm and 488 nm of laser exposures but the prophase aberration induced by EMS treatment was higher than 476 nm and 488 nm and lower than 514 nm of laser exposures.

3. In *V. faba* prophase aberration induced by 488 nm and 514 nm were higher and similar and higher than that induced by 476 nm.

4. UV, γ-irradiations and EMS treatments induced prophase aberration lower than 488 nm and 514 nm but similar to 476 nm laser exposures. HA induced prophase aberration higher than 476 nm and lower than 488 and 514 nm laser exposures.

6.1.2 Metaphase aberration

1. In *A. cepa* metaphase aberration induced by 488 nm and 514 nm of laser exposures were similar.

2. Metaphase aberration caused by UV was lower than 488 and 514 nm but similar to 476 nm of laser exposures. Metaphase aberrations induced by EMS and HA treatments were similar and was higher than that induced by laser exposures.

3. In *V. faba* metaphase aberration induced by 488 nm of laser exposure was maximum.
4. Metaphase aberration induced by γ, EMS and HA treatments were higher than that caused by all three wavelengths of laser exposures. UV induced metaphase aberration frequency similar to 488 nm and higher than 476 nm and 514 nm.

5. In A. cepa anaphase aberration induced by laser exposures were maximum at 476 and 488 nm and were similar in frequency.

6. Anaphase aberration caused by UV and EMS were similar to that induced by 476 and 488 nm but higher than 514 nm laser exposures. HA induced anaphase aberration similar to 514 nm but lower than 476 and 488 nm lasers.

7. In V. faba, anaphase aberration induced by 476 nm of laser exposure was maximum.

8. Anaphase aberration induced by γ-irradiations and that induced by 476 nm of laser exposure were similar but higher than 488 and 514 nm of laser exposures, while the anaphase aberration induced by UV was lower than that induced by all laser exposures. The frequency of anaphase aberrations induced by EMS and HA treatments were lower to 476 nm but similar to 488 nm and 514 nm of laser exposures.

6.1.3 Telophase aberration

1. In A. cepa, telophase aberration induced by laser exposures were similar and maximum at 476 and 488 nm of laser exposures.

2. Telophase aberration induced by UV and HA treatments were lower than that induced by laser exposures of all three wavelengths but telophase aberration induced by EMS was similar to that induced by 514 nm and lower than 476 and 488 nm of laser exposures.
3. In *V. faba*, laser exposure of 488 nm induced maximum telophase aberration frequency.

4. Telophase aberration induced by γ-irradiations were several fold higher than that induced by laser exposures. Telophase aberration induced by UV exposures was similar to that induced by 514 nm but lower than 476 and 488 nm of laser exposures. EMS caused telophase aberration similar to 47 nm, higher to 514 nm and lower than 488 nm of lasers. HA treatment induced telophase aberration similar to that induced by 514 nm but lower than 476 and 488 nm of laser exposures.

### 6.1.4 Total mitotic aberration

1. In *A. cepa*, total mitotic aberration was maximum at 400 mW power density of 488 nm and 514 nm laser exposures.

2. Total mitotic aberration induced by UV exposures was lower than that caused by laser exposures in all three wavelengths. Total aberration induced by EMS treatment was similar to that induced by 400 mW power density of 488 and 476 nm but higher than 514 nm and 200 mW of 488 nm and 476 nm. Total aberration induced by HA treatment was similar to that induced by 514 nm and 200 mW of 476 nm but lower than 488 nm and 400 mW of 514 nm laser exposures.

3. In *V. faba*, total mitotic aberration was maximum at 400 mW power density of 488 nm laser exposure.

4. Total aberration induced by UV, EMS and HA were similar to that caused by 514, 476 nm and 200 mW of 488 nm but lower than 400 mW of 488 nm laser exposures. Total aberration induced by γ-irradiations were 4-5 fold higher to that induced by laser exposures.
6.1.5 Mitotic index

1. In *A. cepa*, laser exposures induced lowest mitotic index at 488 nm.

2. Mitotic index induced by UV exposures were higher than 488 nm but similar to 476 and 514 nm laser exposures. Mitotic indices induced by EMS and HA treatments were similar to that induced by laser exposures of 514 nm but higher than 488 nm and lower than 476 nm.

3. In *V. faba*, laser exposures induced mitotic indices similar in all three wavelengths.

4. Mitotic index induced by UV exposures was higher than that induced by laser exposures. Mitotic indices of EMS, HA and γ-irradiations were similar to the mitotic indices induced by laser exposures.

6.2 Meiotic aberration

6.2.1 Clumping of chromosomes

1. Clumping of chromosomes induced by laser exposures was maximum at 488 nm.

2. Clumping of chromosomes induced by γ-irradiations and EMS treatments were higher than that induced by laser exposures in all three wavelengths. Clumping of chromosomes induced by UV and HA treatments was higher than that induced by 476 and 514 nm but lower than 488 nm of laser exposures.

   **Stickiness of chromosomes**

3. Stickiness in laser treatments was maximum at 514 nm.

4. Stickiness induced by UV exposures was similar to that induced by 476 and 488 nm of laser exposures but lower than 514 nm of laser exposure. Stickiness induced by γ and EMS treatments was higher than that induced
by laser exposures. Stickiness induced by HA treatment was similar to 526 nm but higher than 476 and 488 nm of laser exposures.

6.2.2 Bridges

1. Bridges induced by laser exposures was highest at 200 mW power density of 514 nm.
2. Bridges were absent in UV exposures. Bridges induced by γ-irradiations were similar to that induced by laser exposures but bridges induced by EMS 0.2% was similar and EMS 1% was several fold higher than that induced by laser exposures. Bridges induced by HA treatment was higher than that induced by 476 nm of laser exposure and 200 mW power density of 488 nm, similar to 400 mW power density of 514 nm and lower than 400 mW of power density of 488 nm and 200 mW power density of 514 nm.

6.2.3 Laggards

1. Laggards were not found in all laser exposures. 488 nm of laser exposure induced highest laggard frequency.
2. Laggards were not induced by UV exposures, 1% concentration of EMS and 0.2% of concentration of HA. Laggards induced by γ-irradiations were similar to that induced by laser exposures while EMS and HA treatments induced laggard frequency lower than that induced by laser.

6.2.4 Unequal distribution of chromosomes

1. Unequal distribution of chromosomes in laser exposures were maximum at 200 mW power density of 514 nm.
2. Unequal distribution of chromosomes induced by UV exposures and HA treatments was higher than that induced by laser exposures but the same induced by γ-irradiations was lower than that induced by laser exposures.
Unequal distribution of chromosomes induced by EMS treatments were several fold higher than that induced by laser exposures.

### 6.2.5 Micronucleate cells

1. Micronucleate cells were not found in most of the treatments. It was seen only at 200 mW power density of 488 nm. Micronucleate cells induced by UV 3 hour, 15 KR $\gamma$-irradiation and HA 1% treatments were higher than that induced by laser exposures.

### 6.2.6 Total meiotic aberration

1. Total meiotic aberration was found to be highest at 488 and 514 nm of laser exposure.

2. Meiotic aberration induced by UV has lower than that induced by 488 nm and 514 nm and higher than 476 nm laser exposures but $\gamma$-irradiations and EMS treatments caused increase in total aberration compared to that induced by laser exposures. HA caused total aberration similar to that induced by laser exposures.

### 6.3 Pollen sterility

1. Pollen sterility was maximum at 400 mW power density of 488 mW.

2. Pollen sterility induced by UV exposures and 2,5,10 and 15 kR's of $\gamma$-irradiations, 0.2% EMS and HA treatments were similar to that induced by 476 nm and 200 mW power density of 488 nm but lower than 400 mW power density of 488 nm and 514 nm laser exposures. Pollen sterility induced by 20 kR of $\gamma$-irradiations, 1% of EMS treatments and 1% HA treatments were several fold higher than that induced by laser exposures.
0.4.1 Sprouting/germination index

1. Sprouting index in *A. cepa* induced by 476 nm and 200 mW power density of 514 nm was maximum in laser exposures. Sprouting index of 476 nm was similar to control value but 200 mW power density of 514 nm was higher to control value.

2. Sprouting index induced by UV 3 hour and EMS 1% treatments was similar to these and higher than that induced by 488 nm and 400 mW power density of 514 nm laser exposures and was higher than control value. Sprouting index of EMS 0.2% and HA 1% treatments were lower than that induced by laser exposures and control value. Sprouting index induced by UV 1 hour and HA 0.2% were similar to control and that induced by 400 mW power density of 488 nm and 514 nm but 200 mW power density of 488 nm was lower than it.

3. Germination index in *V. faba* induced by 488 nm laser exposure was maximum.

4. Germination index of 2 kR and 5 kRs's of γ-irradiations was similar to control value and was higher than that induced by laser exposures. But 10 kR, 1 kR and 20 kR induced dose dependent decrease in germination index and was several fold lower than control and that induced by laser exposures. UV induced germination index similar to that induced by 514 nm laser exposures but lower than that induced by 488 nm laser exposure and control. EMS induced germination index higher than that induced by laser exposures. This value of 0.2% EMS treatment was higher and of 1% similar to that of control value. HA treatment induced germination index several fold lower than that induced by laser exposures and control.
6.4.2 Growth rate

1. In A. cepa, growth rate induced by laser exposures was maximum at 514 nm and was higher to control.

2. The growth rate induced by UV 1 hour was higher than control, similar to that induced by 488 nm of laser exposure but lower than 514 nm of laser exposure while UV 3 hours induced growth rate lower than control and that induced by laser exposure.

3. EMS 0.2% induced growth rate similar to but 1% lower than control. Growth rate induced by EMS was lower than that induced by laser exposures. HA treatment induced growth rate higher to control but similar to 488 nm and lower than 514 nm laser exposures.

4. In V. faba, growth rate was maximum at 400 mW of 488 nm induced by laser exposure and higher than that of control.

5. UV induced growth rate lower than that induced by laser exposures and was higher than control. γ-irradiations induced growth rate lower than that induced by laser exposures. 2 kR and 5 kR growth rate was similar but 10 kR, 15 kR and 20 kR lower than that of control. EMS treatments induced growth rate lower than that induced by laser exposures but higher than that of control (untreated) value. HA treatment induced decrease in growth rate and was lower than that induced by laser exposures and control. 1% HA treatment plants did not attained full growth.

6.4.3 Yield

1. In A. cepa, yield induced by laser exposures was maximum at 400 mW power density of 488 nm and was almost two fold higher than the yield of control.
2. UV exposures, EMS and HA treatments induced yield higher than that of control but lower than the yield induced by laser exposures.

3. In *V. faba* yield was maximum at 400 mW power density of 488 nm and the yield in laser exposures was higher than the yield of control.

4. Yield in UV 1 hour exposure were similar than the yield of 514 nm and 200 mW power density of 488 nm but lower than 400 mW power density of 488 nm laser exposures and similar to the yield of control. UV 3 hours exposure induced yield was lower than all laser exposures and control. Yield in $\gamma$-irradiated, EMS treated and HA treated samples was lower than control and laser exposures yield value. $\gamma$-showed dose dependent decrease in yield and 1% HA treated plants did not survive till maturity.

**6.5.1. Soluble protein content**

1. In *A. cepa*, laser exposures induced increase in soluble protein content in inner true leaves and outer fleshy scale leaves higher than control. Soluble protein content in outer fleshy scale leaves was higher than in inner true leaves.

2. $\gamma$-Irradiations induced decrease in soluble protein content in inner true leaves and outer fleshy leaves lower than control. EMS treatments also induced decrease in soluble protein content in inner true leaves and outer fleshy scale leaves and it was lower than the control.

3. In *V. faba*, laser exposures of 476 nm and 488 nm induced increase in soluble protein content but 514 nm decreased soluble protein content when compared to control. Soluble protein content in embryo was less than control on third day but similar to control on sixth day. Soluble protein content in cotyledon was higher than that of the embryo in control, 476 and
488 nm of laser exposures but at 514 nm of laser exposures soluble protein content in embryo was higher than that in cotyledon.

4. γ-irradiations of all doses induced increase in soluble protein content on sixth day in cotyledon than control but on third day it was similar to control. In embryo on third day soluble protein content in γ-irradiated samples was less than control but on sixth day it was similar to control.

5. EMS treatments caused decrease in soluble protein content in cotyledon on third and increase in soluble protein content on sixth day when compared to control. Soluble protein content in embryo decreased on sixth day and on third day decreased at 0.2% and significantly increased at 1% EMS treatment when compared to control. Soluble protein content in cotyledon was higher than in embryo.

6.5.2 Protease activity

1. In *A. cepa*, laser exposures at 476 and 488 nm induced no significant change in activity compared to control but specific activity increased with increase in dose in samples exposed to these two wavelengths. Activity and specific activity was higher than outer fleshy scale leaves than inner true leaves. Activity and specific activity decreased with increase in power density at 514 nm of laser exposures.

2. γ-irradiations induced decrease in activity and specific activity of protease in *A. cepa*. EMS treatment did not show significant variation in treated samples compared to that of control. Specific activity in inner true leaves of samples treated with EMS showed decrease with increase in dose on second day and was several fold lower than control, but specific activity in outer fleshy scale leaves on second day showed increase with increase in dose and was higher than control. Significant variation was not observed on fourth day in specific activity in outer fleshy scale leaves and in inner true leaves.
3. In *V. faba*, laser exposures at 476 and 488 nm induced increase in activity and specific activity in cotyledons and embryo and was higher than control value. Increase in activity with increase in power density was found at 488 nm but decrease in enzyme activity with increase in power density was found at 476 nm. 514 nm caused decrease in enzyme activity. Variation in specific activity was found in embryo but no variation in specific activity was found in cotyledon.

4. γ-irradiations induced no significant change in enzyme activity and specific activity. Activity in treated samples was higher than control. EMS treatment did not show much variation in enzyme activity in embryo and cotyledon. It was lower than control in embryo and similar to control in cotyledon specific activity showed variation in embryo with control but no significant variation was observed in cotyledon.

### 6.5.3 Amylase activity

1. In *A. cepa* laser exposures did not show significant change in amylase activity compared to control but specific activity was higher than control.

2. γ-irradiations caused dose dependent increase in activity and specific activity. EMS treatment caused significant decrease in enzyme activity at 0.2% although not much difference was noticed at 1% when compared to control. Specific activity showed variation in inner true leaves and outer fleshy leaves when compared to control.

3. In *V. faba*, no significant difference in amylase activity in laser exposed samples compared to control samples was observed. Specific activity in embryo showed variation but cotyledon showed no significant variation compared to control.

4. γ-irradiations induced slightly higher activity and specific activity in cotyledon and embryo compared to control. EMS treatment caused decrease
in amylase activity in cotyledon and embryo on fourth day but on second
day variation in activity was found when compared to control. Specific
activity showed no significant change in cotyledon but in embryo variation
was observed compared to control.

6.5.4 Peroxidase activity

1. In *A. cepa*, peroxidase activity is significantly absent or very low in outer
fleshy scale leaves as compared to the inner true leaves. Laser exposures
caused no significant change in enzyme activity in inner true leaves
compared to control.

2. γ-irradiations caused transient increase in peroxidase activity in irradiated
samples compared to control and no dose dependence was found. EMS
treatment also caused an increase in peroxidase in inner true leaves
compared to control.

3. In *V. faba*, laser exposure at 514 nm induced increase in peroxidase activity
in cotyledon. Peroxidase activity was lower than control in the cotyledon and
embryo in all other laser exposures.

4. γ-irradiations showed variations in peroxidase activity in embryo and
cotyledon in *V. faba* compared to control. EMS caused transient increase in
peroxidase activity in embryo with increase in treatment concentration but
in cotyledon enzyme activity showed variation compared to control.

6.5.5 Catalase activity

1. In *A. cepa*, catalase activity was significantly absent in the outer fleshy
leaves compared to the inner true leaves. Laser exposures at 488 nm and
514 nm caused no significant change in catalase activity but 476 nm
causd increase in activity with dose.

2. γ-irradiations induced increase in enzyme activity in irradiated samples
compared to control but no dose dependence was found. EMS treatment
caused increase in catalase activity on second day compared to control in inner true leaves but on fourth day variation in activity was found.

3. In *V. faba*, catalase activity was absent in embryo and found only in cotyledon of both control and treated samples.

4. Laser exposures of 476 nm and 514 nm decreased enzyme activity with increase in power density but at 488 nm the activity increased with increase in power density in *V. faba*.

5. γ-irradiations induced decrease in enzyme activity compared to control and varied in different doses. EMS treatment caused variation in enzyme activity in embryo in *V. faba*.