Section A-Research

Effect of Plant Extracts on Germination, Growth and Yield of Okra [*Abelmoschus esculentus* (L.) Moench]

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Abstract:

This research was conducted to overcome the problem of slow and erratic emergence in okra and to find out the effect of plant extracts on germination, growth and yield in okra at Research Field of Lovely Professional University (LPU), Phagwara, Punjab, India (March-June, 2022). Punjab Suhawani variety was used for experiment. The experiment was laid out in Randomized Block Design (RBD) with 8 treatments and 3 replications, i.e. T_1 (Amla leaf extract@ 3%), T_2 (Tulsi leaf extract@ 3%), T_3 (Reetha leaf extract@ 3%), T_4 (Bael leaf extract@ 3%), T_5 (Arjuna leaf extract@ 3%), T_6 (Neem leaf extract@ 3%), T_7 (Baheda leaf extract@ 3%) and T_0 (Control). Field experiment results showed that seed treatments with different plant botanicals proved effective in improving germination percent, improving the growth parameters (seedling shoot length, seedling root length, seedling length, fresh weight of seedlings, dry weight of seedlings, seedling vigour index-I, seedling vigour index-II, plant height, number of leaves and yield contributing characters like number of pods per plant, length of pods, width of pods, individual pod weight, pod yield per plant (g), pod yield (kg/plot) and pod yield (tonnes/ha) as compared to control (un-treated seeds). The highest and lowest germination percentages were found in T_5 (Arjuna leaf extract@ 3%) and T_0 (Control) respectively while better growth performance in T_5 (Arjuna leaf extract@ 3%) and T_7 (Baheda leaf extract@ 3%). Similarly, T_5 (Arjuna leaf extract@ 3%) and T_7 (Baheda leaf extract@ 3%) resulted in higher yield. Hence, it is suggested that seed treatments with different plant botanicals is important to improve the overall germination, growth performance and yield in okra.

Keywords: plant extracts, seed treatment, okra, growth and yield.

Introduction

Okra [*Abelmoschus esculentus* (L.) Moench] belongs to the family *Malvaceae* which is widely cultivated all over the world and well known for its flavor and nutritional value (Naveed *et al*., 2009). It is originated from Ethiopia but now it has been expanded across the world's tropical, subtropical and warm temperate zones. In many countries okra is also known as bhindi, lady's finger, bamia or gumbo (Jain *et al*., 2012). High-quality protein can be found in okra seeds because it has a higher concentration of essential amino acids than other plant protein sources (Omoniyi *et al*., 2021). Okra is vital component of plasma replacement therapy and blood volume expansion medicine. Okra mucilage has different commercial uses, such as a glazing agent for paper (Benchasri, 2012). Okra fruit also contains some of the antioxidants flavonoid like beta carotene, xanthein and lutein (Dilruba *et al*., 2009). Okra fruit is a rich source of iodine. Okra thrives in a warm climate during the growing season. Best temperature for the germination of okra seed is 29 ^{0}C. Okra do not germinate below 17 ^{0}C. Flowering and fruit setting in okra are inhibited by temperatures over 42 ^{0}C (Muthukumar & Selvakumar, 2017). Globally, India is the leading producer of okra followed by Nigeria and Sudan. Because of the presence of the hard seed coat of okra the percentage of seeds germination is relatively low (Felipe *et al*., 2010). Hard seed coat is major problem in germination of okra which restricts water from being absorbed and prevents uniform growth of embryos (Girase *et al*., 2019).

Different strategies related to improve the growth and development of plants have been investigated from many years. Among these, seed treatments with different plant botanicals is universally used innovative technique to improve quality of seeds. Botanical seed treatment is a liquid mixture that promotes early and uniform seed germination as well as increases resistance to pests and diseases in the early stages of crop development. Microbes that are present in plant botanicals secrets some plant growth regulators like auxins and cytokinins, which promote plant growth and enhance seed germination and root growth of the seedlings (Girase *et al*., 2019). Therefore, the current studies were conducted to ascertain the impact of different plant botanicals on germination, growth and yield of okra. At the end of study, the best technique found is planned to be recommended to the farmers.

Materials and Methods

Experimental Site

This study was carried out at Research Field of Lovely Professional University (LPU) Phagwara, Punjab, India during between March and June of 2022. The geographic location of experimental site was at elevation of 245 meter above mean sea level.

Experimental Design

The experiment was laid out in Randomized Block Design (RBD) with 8 treatments and 3 replications. Detailed information about the experiment was presented in Table 1 and Table 2.

Table 1. Treatment details used in experiment

S.N.	Treatments	Botanical agents used
1	T_1	*Phyllanthus emblica* (Amla) Leaf Extract@ 3%
2	T_2	*Ocimum tenuiflorum* (Tulsi) Leaf Extract@ 3%
3	T_3	*Sapindus mukorossi* (Reetha) Leaf Extract@ 3%
4	T_4	*Aegle marmelos* (Bael) Leaf Extract@ 3%
5	T_5	*Terminalia arjuna* (Arjuna) Leaf Extract @ 3%
6	T_6	*Azadirachta indica* (Neem) Leaf Extract@ 3%
7	T_7	*Terminalia bellirica* (Baheda) Leaf Extract@ 3%
8	T_0	Control

Table 2. Details of layout

1	Design: RBD	7	Plot size: 1.35 m×1.50 m (2.025 m^2)
2	Name of crop: Okra	8	Total plot area: 15.30 m×7.5 m (114.75m^2)
3	Variety: Punjab Suhawani	9	Row to row distance: 45 cm
4	No. of replications: 3	10	Plant to plant distance: 15 cm
5	No. of treatments: 8	11	Total number of plants / plot: 30
6	Total number of plots: 8×3 (24)	12	Sowing date: 28th March, 2022

Procedure for preparation of botanical leaf extract treatments:

Punjab Suhawani variety of okra purchased from "Punjab Agricultural University (PAU), Ludhiana." was used for the experiment. The seeds were hand sorted to eliminate broken and

damaged seeds. 100 of seeds was weighed for each treatment. After soaking the seeds for twelve hours in different leaf extract solutions at room temperature, the seeds were shade dried and brought back to their original moisture content. The dried seeds were used as controlled (un-treated) seeds.

Agronomic Practices

One cross cultivation, followed by two harrowings, was done by a tractor drawn cultivator to get proper tilth of the soil before seed sowing. Farm yard manure 20 t/ha and Urea 190-200 kg/ha were applied as the source of nitrogen, phosphorus and potassium respectively to meet the recommended dose of Nitrogen-Phosphorus-Potassium (NPK) for okra cultivation (i.e. 200:180:60 kg ha^{-1}). The treated seeds were sown on 28th March, 2022 using local dibbling stick to make holes. To ensure effective germination, seeds were sown 2-5 cm deep. Necessary agricultural practices (weeding, irrigation) were done through the cropping season for proper growth and development of the plant. From each plot, five plants were randomly selected and tagged to record various observations on a daily basis as per the proposed schedule.

Observations recorded

Okra germination, growth, and yield characteristics were measured by tagging five randomly selected plants leaving the border rows, and average values were calculated. Below are the details of the observations recorded.

Growth Parameters:

1. **Germination percentage (%)**

In order to determine the seed germination rate, the number of germinated seeds was recorded on a daily basis. The formula below was used to calculate seed germination (percentage).

$$\textbf{Germination percentage (\%)} = \frac{\text{Number of normal seedlings germinated x 100}}{\text{Total number of seeds kept for germination}}$$

2. **Shoot length of seedling (cm)**

During the 28-day growth period, the seedlings were uprooted and distilled water was used to remove the sand lodged in their roots. The length of the shoot, from the hypocotyl to the tip, was measured on a centimeter scale for 5 randomly chosen seedlings from each treatment. The mean value of all treatments was determined.

3. **Root length of seedling (cm)**

Seedlings were uprooted after 28 days of growth and washed with water to remove foreign sand

particles. The length of the longest root from the base of hypocotyls of five randomly selected seedlings within each treatment was measured using a centimeter scale. The mean value of all treatments was determined.

4. Seedling length (cm)

From the primary leaf tip to the primary root tip, the length of five randomly selected seedlings was measured in centimeters for each treatment using centimeter scales. The mean value of all treatments was calculated.

5. Fresh weight of seedling (g)

A filter paper was used to absorb any moisture still remaining on the leaves and shoots after measuring root and shoot lengths on the seedlings. Seedling fresh weight was then measured using a digital balance.

6. Dry weight of seedling (g)

In order to measure the dry weight of seedlings, five randomly selected seedlings from each treatment were placed in paper bags and dried at 70 degrees celsius for 72 hours. A digital balance was used to measure the dry weight of the seedlings.

7. Seedling Vigour Index-I

Based on Abdul-Baki and Anderson's 1973 formula, the Seedling Vigour Index-I was calculated.

Seedling Vigour Index-I = Germination (%) x Length of seedling (cm)

8. Seedling Vigour Index-II

Based on Abdul-Baki and Anderson's (1973) formula, the Seedling Vigour Index-II was calculated.

Seedling Vigour Index-II = Germination (%) x Dry weight of seedling (g)

9. Plant height (cm)

In each treatment, five randomly selected plants were measured in centimeters from ground level to the tip of the plant by means of a centimeter scale. The average height of plants was calculated. To observe plant growth, measurements were taken at 30, 45, 60 and 75 days intervals starting from 30 days after sowing to harvesting time.

10. Number of leaves per plant

From each randomly tagged plant, total leaves per plant were counted. In order to calculate the data, five randomly selected plants were chosen from each plot's inner rows between 30 days after sowing up to harvesting time at a 15-day interval.

Yield Parameters:

1. **Number of pods per plant**

A total of five randomly selected plants were counted and averaged to determine the number of pods per plant.

2. **Length of the pod (cm)**

A centimeter scale was used to measure the length of green pods from the tip of their necks to the bottom of the pods in each plot. The average length was calculated and expressed in centimeters.

3. **Pod diameter (mm)**

A digital vernier caliper was used to measure the diameter of green pods at the top, middle, and bottom portions of each plot. Their average was calculated in millimeters.

4. **Individual weight of the pod (g)**

An electronic weighing balance was used to record the weight of each pod from five randomly selected plants from each treatment. Their average was calculated in grams.

5. **Pod yield per plant (g)**

A total yield per plant was calculated for each treatment by picking fresh pods from each tagged plant separately and placing them in separate polythene bags.

6. **Pod yield per plot (kg)**

A total average yield per plot was calculated from each treatment after picking fresh pods from all plots in separate polythene throughout the harvesting period.

7. **Yield (kg ha-^{1})**

Based on the yield of each subplot, the following formula was used to compute the yield (kg ha^{1}):

$$\textbf{Yield kg ha-}^{\mathbf{1}} = \frac{\text{Yield per sub plot (kg)} \times 10000\ \text{m}^2}{\text{Area of sub plot (m}^2\text{)}}$$

8. **Pod yield (tonnes/ha)**

A total average yield in tonnes/ha has been calculated from each treatment after each plot's fresh pods have been picked separately in separate polythene bags throughout the harvesting period. Crop yield is determined by a variety of factors, including soil type, environmental conditions,

and genetic makeup. Priming might increase biochemical yields due to better seedlings and nutrition. Priming seeds may improve germination and uniformity, resulting in increased yields.

Statistical Analysis

Statistical analysis was conducted for each observed character using MS Excel and OPSTAT. Randomized Block Design analysis of variance was performed on the mean values of the data as recommended by Gomez and Gomez (1984).

Results and Discussion

Effect of plant extracts on germination percentage (%)

The observation recorded for germination percentage (%) of okra for the year 2022 have been presented in Table 3. There was a considerable difference between the different treatments with respect to germination percentage (%). The highest germination percentage (82.22) was observed in treatment T_5 (Arjuna) which was *at par* (78.89) with the treatment T_7 (Baheda) whereas lowest germination percentage (61.11) was recorded in treatment T_0 (control) which was *at par* (64.44) with the treatment T_6 (Neem). Aqueous extracts of *Terminalia arjuna* leaves were also found to promote the germination of okra (Roy *et al*., 2012). Many researchers suggested that plant extracts contain a large number of microbes, and those microbes are efficient in causing plant growth because they secrete plant growth promoters (auxins, abscisic acid, gibberellic acid and cytokines) that encourage seed germination.

Effect of plant extracts on growth (shoot length, root length and seedling length)

The observation recorded for seedling shoot length, seedling root length and seedling length of okra for the year 2022 have been presented in Table 3. There was a significant difference between the different treatments with respect to seedling shoot length, seedling root length and seedling length (cm). The highest seedling shoot length (12.77) was recorded in treatment T_5 (Arjuna) which was followed by the treatment T_7 (Baheda) (12.22), whereas lowest seedling shoot length (8.13) was recorded in treatment T_0 (control) followed by T_6 (Neem). The maximum seedling root length (12.27) was recorded in treatment T_5 (Arjuna) which was followed by the treatment T_7 (Baheda) (11.72), whereas minimum seedling root length (7.63) was recorded in treatment T_0 (control). The maximum seedling length (25.03) was recorded in treatment T_5 (Arjuna) which was followed by the treatment T_7 (Baheda) (23.93), whereas minimum seedling

length (15.77) was recorded in treatment T_0 (control). The other treatments showed moderate performance. According to the (Roy *et al*., 2012), Arjuna (*Terminalia arjuna*) and baheda (*Terminalia bellirica*) leaves extracts promote cell growth of the seedlings. Several growth-regulating substances may be responsible for increased growth of the seedlings. Additionally, physiological and biochemical changes may have increased the embryo's physiological activity and mobilized food reserves so that the seedlings grew longer and stronger (Rahman *et al*., 2016).

Effect of plant extracts on seedling weight and vigour index

The observation recorded on fresh weight of seedlings, dry weight of seedlings, seedling vigour index-I and seedling vigour index-II of okra for the year 2022 have been presented in Table 3. There was a remarkable difference between the various treatments with respect to fresh weight of seedlings, dry weight of seedlings, seedling vigour index-I and seedling vigour index-II. The highest fresh weight of seedlings (1.51) was recorded in treatment T_5 (Arjuna) which was followed by the treatment T_7 (Baheda) (1.33), whereas lowest fresh weight of seedlings (0.79) was observed in treatment T_0 (control). Similarly, the highest dry weight of seedlings (0.70) was recorded in treatment T_5 (Arjuna) which was followed by the treatment T_7 (Baheda) (0.62), whereas lowest dry weight of seedlings (0.36) was recorded in treatment T_0 (control). Also, the maximum seedling vigour index-I (2058.30) was observed from treatment T_5 (Arjuna) which was followed by the treatment T_7 (Baheda) (1888.07), whereas the minimum seedling vigour index-I (963.52) was observed from treatment T_0 (control). And the maximum seedling vigour index-II (57.28) was recorded from treatment T_5 (Arjuna) which was followed by the treatment T_7 (Baheda) (49.17), whereas the minimum seedling vigour index-II (22.20) was recorded from treatment T_0 (control) which was *at par* (26.64) with the treatment T_6 (Neem). According to (Catiempo *et al*., 2021) a synchronised and uniform emergence of seedlings as well as improved dry weight, shoot length, and fresh weight of seedlings was observed from treated seeds. According to Hussain *et al*. (2017), de novo hydrolase production occurs during seed treatments, enabling food reserves to be broken down and transported to growing embryos efficiently. Even in stressful conditions, the seedlings completed major developmental processes due to this vigorous start. Renugadevi *et al*. (2008) likewise came to the conclusion that fortifying clusterbean with arappu leaf extract at one and two percent concentrations improved germination, vigour, and field emergence. According to Sedghi *et al*. (2010), seed treatment may

enhance seed germination efficiency and seedling growth by improving seed vigour index.

Table 3: Effect of different plant extracts on germination and growth parameters of okra

Treatments	Germination percentage (%)	Seedling shoot length (cm)	Seedling root length (cm)	Seedling length (cm)	Fresh weight of seedlings (g)	Dry weight of seedlings (g)	Seedling vigour index-I	Seedling vigour index-II
T_1	72.22	11.05	10.55	21.60	0.95	0.48	1560.00	34.43
T_2	71.11	10.53	10.03	20.57	0.91	0.44	1462.52	31.29
T_3	68.89	9.87	9.37	19.23	0.89	0.43	1324.96	29.62
T_4	75.56	11.70	11.20	22.90	1.12	0.53	1730.22	40.04
T_5	82.22	12.77	12.27	25.03	1.51	0.70	2058.30	57.28
T_6	64.44	8.87	8.37	17.23	0.87	0.41	1110.59	26.64
T_7	78.89	12.22	11.72	23.93	1.33	0.62	1888.07	49.17
T_0	61.11	8.13	7.63	15.77	0.79	0.36	963.52	22.20
CD (P=0.05)	6.50	0.35	0.35	0.71	0.08	0.05	138.47	5.02
CV (per cent)	5.12	1.88	1.97	1.92	4.49	5.66	5.18	7.80

Effect of plant extracts on plant height at different days intervals

The observation recorded on plant height (cm) of okra at different days intervals for the year 2022 have been presented in Table 4. There was a significant variation in treatments with respect to plant height (cm) at 30, 45, 60 days and at final harvesting. At 30, 45, 60 days and at final harvesting, the highest plant height (25.03 cm, 34.24 cm, 54.26 cm and 64.34 cm respectively) was recorded in treatment T_5 (Arjuna). At final harvesting the maximum plant height (64.34 cm) was recorded from treatment T_5 (Arjuna) which was *at par* (63.08 cm) with the treatment T_7 (Baheda). Similarly at 30, 45, 60 days and at final harvesting, the minimum plant height (15.77 cm, 21.11 cm, 41.02 cm and 52.00 cm respectively) was recorded in treatment T_0 (control). At final harvesting the lowest plant height (52.00 cm) was recorded in treatment T_0 (control) which

was *at par* (53.91 cm) with the treatment T_6 (Neem). According to (Shah *et al*., 2011), plant height is a function of the genetic as well as the enviormental condition. It is considered as expression of its full vegetative potential and reproductive cycle. The enhanced plant height in primed seed plots may be due to improved and faster emergence in primed seed plots which created cooperative competition among the plants for light, water and nutrients and resulted in taller plants. Probable reason could be that priming might have increased seedling vigour which had enhanced the competitiveness for light, water and nutrients. The results are in agreement with the work of Shah *et al*. (2011) who reported that seed priming has been shown to improve plant stands.

Table 4: Effect of plant extracts on plant height at different days intervals.

Treatments	Plant height at 30 days (cm)	Plant height at 45 days (cm)	Plant height at 60 days (cm)	Plant height at final harvest (cm)
T_1	21.60	29.27	49.23	60.02
T_2	20.57	27.15	47.17	59.73
T_3	19.23	25.38	45.35	56.52
T_4	22.90	31.07	50.99	62.27
T_5	25.03	34.24	54.26	64.34
T_6	17.23	23.13	43.09	53.91
T_7	23.93	32.72	52.72	63.08
T_0	15.77	21.11	41.02	52.00
CD (P=0.05)	0.71	0.60	0.63	2.04
CV (per cent)	1.92	1.21	0.75	1.95

Effect of plant extracts on number of leaves at different days intervals.

The perusal data for number of leaves per plant of okra at different day's intervals for the year of 2022 have been presented in the Table 5. There was a remarkable differences in treatments with respect to number of leaves at 30, 45, 60 days and at final harvesting. At 30, 45, 60 days and at final harvesting, the maximum number of leaves (6.00, 22.53, 30.57 and 36.20 respectively) was recorded in treatment T_4 (Bael). Similarly at 30, 45, 60 days and at final harvesting, the minimum number of leaves (4.00, 10.63, 16.53 and 21.60 respectively) was recorded in treatment T_0 (control). At 30 days the lowest number of leaves (4.00) was observed from treatment T_0

(control) which was *at par* (4.33) with the treatment T_6 (Neem). According to Basra *et al*. (2003) several crops showed an increase in tillers and leaves after the seed treatment. According to their findings, these improvements were correlated with the faster and more uniform emergence of seedlings.

Table 5: Effect of plant extracts on number of leaves at different days intervals.

Treatments	Number of leaves per plant (30 days)	Number of leaves per plant (45 days)	Number of leaves per plant (60 days)	Number of leaves per plant (final harvest)
T_1	4.67	16.57	23.40	29.40
T_2	4.57	15.13	19.53	26.00
T_3	4.50	13.57	18.60	24.53
T_4	6.00	22.53	30.57	36.20
T_5	4.73	19.30	26.40	31.53
T_6	4.33	12.10	18.00	23.23
T_7	5.50	21.10	29.07	33.90
T_0	4.00	10.63	16.53	21.60
CD (P=0.05)	0.50	0.85	0.81	1.62
CV (per cent)	5.93	2.95	2.01	3.23

Effect of plant extracts on number of pods per plant

The perusal data presented in the Table 6 for the year of 2022 on number of pods per plant of okra. There was a remarkable differences in treatments with respect to number of pods per plant. The most number of pods per plant (9.67) was recorded from treatment T_5 (Arjuna). On the other hand, the minimum number of pods per plant (6.80) was recorded from treatment T_0 (control). Final yield is strongly influenced by the number of pods per plant. The number of pods is directly related to the number of leaves. In addition to increased leaves, pods will also increase. Similarly, Ullah *et al*. (2002) reported similar results indicating that seed treatment increases primary branch number and pod number per plant. According to Shah *et al*. (2011), improved emergence and better seedling growth might contribute to the increase in pods. A study by

Sharma *et al*. (2014) reported that fruit yield increases may be due to early emergence. This is due to a higher total emergence rate, a higher number of fruits per plant, and an increase in fruit weight.

Effect of plant extracts on length of pods (cm)

The perusal data presented in the Table 6 for the year of 2022 on length of pods of okra. There was a remarkable differences in treatments with respect to length of pods. The longest pod length (11.48 cm) was recorded from treatment T_5 (Arjuna) which was *at par* (11.12 cm) with the treatment T_7 (Baheda) and also *at par* (10.70 cm) with the treatment T_4 (Bael). On the other hand, the shortest pod (7.91 cm) was recorded from treatment T_0 (control) which was *at par* (8.77 cm) with the treatment T_6 (Neem). The results are in agreement with Rashid *et al*. (2002) who reported that an increase in ear length of wheat is due to the seed priming. This may be due to accumulation of more dry matter content due to healthy crop growth which leads to increase in fruit length.

Effect of plant extracts on width of pods (mm)

The observation recorded on width of pods of okra for the year 2022 have been presented in Table 6. Individual fruit widths at the top, middle and buttom portion of fruit were measured for different treatments. There was a significant variation in treatments with respect to width of pods. The maximum fruit width (12.88 mm) was recorded in treatment T_5 (Arjuna) which was *at par* (11.81 mm) with the treatment T_7 (Baheda). Whereas the minimum fruit width (8.28 mm) was recorded in treatment T_0 (control). In agreement with this results, Hardeep *et al*. (2015) obtained higher fruit length and fruit width of okra from primed seeds.

Effect of plant extracts on individual pod weight (g)

The observation recorded on individual pod weight (g) of okra for the year 2022 have been presented in Table 6. There was a significant variation in treatments with respect to individual pod weight (g). The maximum individual pod weight of okra (11.86 g) was recorded in treatment T_5 (Arjuna) which was *at par* (11.20 g) with the treatment T_7 (Baheda). The minimum individual pod weight of okra (8.23 g) was recorded in treatment T_0 (control). Increasing fruit yield may be caused by early emergence, increased total emergence, heavier fruits, and more fruits per plant,

according to (Sharma *et al*., 2014).

Effect of plant extracts on pod yield per plant (g), pod yield (kg/plot) and pod yield (tonnes/ha).

The observation recorded on *pod yield per plant (g), pod yield (kg/plot) and pod yield (tonnes/ha)* of okra for the year 2022 have been presented in Table 6. There was a significant variation in treatments with respect to *pod yield per plant (g), pod yield (kg/plot) and pod yield (tonnes/ha).* The highest pod yield per plant (g) of okra (114.65 g) was observed in treatment T_5 (Arjuna) which was followed by the treatment T_7 (Baheda) (100.80 g), whereas lowest pod yield per plant (55.94 g) was recorded in treatment T_0 (control). Similarly, the highest pod yield kg/plot of okra (3.44 kg) was observed in treatment T_5 (Arjuna) which was followed by the treatment T_7 (Baheda) (3.02 kg), whereas lowest pod yield kg/plot (1.68 kg) was recorded in treatment T_0 (control). And the highest pod yield tonnes/hectare of okra (16.98 tonnes) was observed in treatment T_5 (Arjuna) which was followed by the treatment T_7 (Baheda) (14.93 tonnes), whereas lowest pod yield tonnes/hectare (8.29 tonnes) was recorded in treatment T_0 (control). Sharma *et al*. (2014) found that a higher fruit yield might be attributed to earlier emergence, a higher total emergence, an increased weight of fruit, and an increased number of fruits per plant. Several factors, including soil type, environment, and genetic makeup, affect crop yield. According to Shah *et al*. (2011), the increased biological yield following seed treatment could be attributed to better early seedling growth and plant nutrition. According to Shah *et al*. (2011) improved germination and vigorous seedling growth resulted in higher yields in treated seed plots, as well as well-developed roots and efficient subsequent growth.

Table 6: Effect of different plant extracts on yield parameters of okra

Treatments	Number of pods per plant	Length of pods (cm)	Width of pods (mm)	Individual pod weight (g)	Pod yield per plant (g)	Pod yield kg/plot	Pod yield tonnes/ha
T_1	8.33	10.38	10.77	10.33	86.08	2.58	12.75
T_2	8.27	9.92	10.31	10.26	84.84	2.55	12.57
T_3	7.87	9.43	9.85	9.80	77.09	2.31	11.42
T_4	8.67	10.70	11.25	10.72	92.88	2.79	13.76
T_5	9.67	11.48	12.88	11.86	114.65	3.44	16.98

T_6	7.20	8.77	9.40	9.35	67.32	2.02	9.97
T_7	9.00	11.12	11.81	11.20	100.80	3.02	14.93
T_0	6.80	7.91	8.28	8.23	55.94	1.68	8.29
CD (P=0.05)	0.32	0.98	1.10	0.98	9.61	0.29	1.43
CV (per cent)	2.21	5.55	5.87	5.42	6.40	6.42	6.41

Conclusion

From this research work it has been concluded that seed treatments with plant botanicals resulted in increase in germination as compared to control (un-treated seeds). Similarly various growth parameters (seedling shoot length, seedling root length, seedling length, fresh weight of seedlings, dry weight of seedlings, seedling vigour index-I, seedling vigour index-II, plant height and number of leaves) were enhanced by seed treatments with plant botanicals as compared to control (un-treated seeds). Seeds treated with Arjuna leaf extract and Baheda leaf extract significantly enhanced growth parameters. Similarly, it was found that seed treatments with plant botanicals increased fruit yield and yield contributing characters such as fruit length and fruit diameter as compared to control (un-treated seeds). In this study, it has been concluded that arjuna leaf extracts and baheda leaf extracts were found to be best seed treatment techniques in terms of germination, growth and yield parameters in okra. Hence these plant botanical may be suggested to the farmers as it is simple and cheap technique compared to other seed treatment techniques.

Acknowledgement

I would like to convey my sincere gratitude, appreciation and thanks to Lovely Professional University for supporting in my research. I am thankful to our research team, Program coordinator & Dr. Dipika Mal ma'am for their regular support, guidance and suggestions throughout my research and preparation for this manuscript. I also owe my gratitude to my parents, friends and all helping hands for their moral and spiritual support.

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