https://doi.org/ 10.48047/AFJBS.6.5.2024.11386-11401

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

A Study the Morphological Parameters of the Eruca Sativa L Plant

Hema Kushwaha[1], Dr. Kanchan Awasthi[2]

[1]Research Scholar, Department of Botany, Maharishi University of Information Technology, Lucknow.
[2]Associate Professor, Department of Botany, Maharishi University of Information Technology, Lucknow.

ArticleInfo

Volume6, Issue5, May2024

Received: 28March2024

Accepted:30 April 2024

Published:17 May2024

doi:
10.48047/AFJBS.6.5.2024.11386-11401

ABSTRACT:

The current study considers two morphological characteristics those are seed germination and seedling morphology. The goal of the research is to achieve heterosis through hybridization. The following parameters were evaluated during the current investigation. Although the physical properties of these three Indian rocket variants are known to some extent and briefly discussed in this paper, they have not been extensively explored. As aresult, one of current investigation's goals wasto characterize these varieties based on morphological characteristics such as seed germination and seedling morphology. Studies of these characteristics for two consecutive years have clearly demonstrated the presence of adequate morphological variability in them. Seedling morphology was investigated by planting 200 seeds of each type in separate iron trays, filling them with uniform soil, and irrigating them at regular intervals. 100 mature seedlings of each variety and F1 intervarietal hybrids were chosen at random to investigate hypocotyl morphology. At the same time, length & breadth of cotyledons weremeasured using a division & scale. The mean cotyledon was determined by multiplying length & breadth of cotyledons.

Keywords: Eruca Sativa L. Plant, Morphological parameters, seed germination and seedling morphology etc.

1. Introduction

Eruca sativa L. belongs to family Brassicacea /.Cruciferae, commonly knownas rocket, taramira and arugula. This is an annual, herbaceous oilseed plant of great economic importance. Plant is used as a leafy vegetablefor its peppery flavour, fresh, tart and bitter test. The plant is having the great medicinal value. The photochemical studies conducted on various parts of *Eruca sativa*, reveals the presence of flavenoid compounds, alkaloids, cardiac glycosides etc. Rocket isnative to Mediterranean region.

Rocket, eruca, or arugula (Erucavesicaria; synonyms: Eruca sativa Mill., E. vesicaria subsp. sativa (Miller) Thell., Brassica eruca L.) is an edible annual species in the Brassicaceae family that is grown as a leaf vegetable for its fresh, acidic, bitter, and peppery flavor. It is also known as garden rocket (in Britain, Australia, South Africa, Ireland, and New Zealand), colewort, roquette, ruchetta, rucola, rucoli, and rugula. E. vesicaria is a classic salad vegetable that originated in the Mediterranean region. (Blamey, 1989; Yaniv 1998)

Rocket, according to historical texts, is an Israeli native plant. Rocket was discovered to be employed as a garden crop and spice in an ancient Israel literary assessment, which included Jewish and Islamic materials from the Middle Ages. Rocket is also a medicinal plant that is used to treat aphrodisiacs, eye infections, digestion, and renal difficulties. This plant contains erucic acid, which is considered a possible future source of industrial oil.

Rocket is also manufactured in Mediterranean nations including Italy, Greece, Moracco, Portgal, and Turkey. In these areas, rocket is also commonly utilized as a garden plant or spice. Accordingto statistics from Turkish StatisticsFoundation (TUIK), plant output in 2010 was expected to be over 4058 tons, which were utilized either fresh in salads or cooked in avariety of recipes.

In addition to its nutritional benefits, the rocket contains powerful phytochemicals, making it valuable in the beauty industry. Rocket is an annual plant that grows to a height of around 20 to 100cm (8 to 40 inches). The leavesare pinnate and deeplylobed, with four to ten little lateral lobes & one huge terminal lobe. The blooms have the characteristic Brassicaceae structure and are grouped in corymbs about 2 to 4 cm in diameter. The petals are creamywhite with purpleveins, or yellow petals with yellow stamens. The fruit is a silique (pod) ranging in length from 12 to 25 mm, with an apical beak & many edible seeds within. This specieshasthe chromosomal number2n = 22.

Fig 1. Leaves Of Eruca Sativa

Fig. 2 Eruca Sativa (Rocket) Seeds

Table 1. Scientific Classification of Eruca Sativa Plant

Kingdom:	**Plantae**
Clade:	Tracheophytes

Clade:	Angiosperms
Clade:	Eudicots
Clade:	Rosids
Order:	Brassicales
Family:	Brassicaceae
Genus:	*Eruca*
Species:	*E. vesicaria*
Binomial name	*Eruca vesicaria* (L.) Cav.
Synonyms	Arugula, Rocket

2. Review Of Literature

J. M Pita Villamil et al. (2002) investigated seed germination and the timing of rocket seed collecting. They also noted the value of rocket as a leaf &oilcrop, particularly as a fourth-generationvegetable.
EV Sastry (2003) investigated the improvement of Eruca sativa. According to him, there are just a few types of this plant, thus genetic advancement is limited. They highlighted that Rocket possesses beneficial features, including disease resistance, that may be passed on to B. juncea and Brassica campestris, both of which are significant crops.
Seema Mahmood and Asma Hussain (2004) investigated the comparative performance ofBrassicanapus&Eruca sativa in deficiency circumstances. They investigated the morphological and phonological features of B. napus and E. sativa in response to drought. Furthermore, species responses varied in terms of tolerance to various drought regimes.
Jessica Barillariet al. (2005) investigated the action of pure glucoerucin, a dietary secondarymetabolite of rocket. They investigated many health-promoting substances such as caratenoids, vitamin C, fibers,flavonoids, &glocosinolates.
Sun-Ju Kim and GenshoIshii (2006) investigated antioxidant &glucosinolate profiles of rocket salad seeds, leaves, and roots. Rocket salad yielded a substance known as methoxyglucobrassicin.
M. SarwarAlam et al. (2007) investigated Rocket's antioxidant activity and found that it protects against mercuric chloride-induced kidney damage. Rocket has a strong reputation for treating renal illnesses and is commonly utilized in folkloric medicine.
Tim Nielsen et al. (2008) investigated the source of unpleasant odors in packaged rucola. They focused on the collection of off-odours in the packing.
Salim Khan and F. Al-Qurainy (2009) investigated rocket seed germination and found that sodium azide has a mutagenic impact. Sodium azide, a chemical mutagen, is commonly employed to increase crop quality and output.
YaseminOzdener et al. (2010) investigated influence of zincon biochemical parameters & growth in seedlings of Eruca sativa L. Under controlled settings, rocket seedlings were treated with various Zn concentrations.
WT Kasem et al. (2011) investigated the seed coat & seed morphological sculpturing of 32Brassicaceae species. LM and SEM were used to evaluate 32 Brassicaceae species and their seed exomorphic characteristics.
Mohamed H AL - Whaibi et al. (2012) investigated the growth performance and photosynthetic pigment status of rockets, as well as effect of plantgrowth regulators. To increase rocket plant performance, the viability of using plant growth regulators (kinetin GA3, spermidine, &napthaline acetic acid) was investigated.

Candida Vannini et al. (2013) investigated the morphological & proteomic responses ofEruca sativa when exposed toNanoparticles (AgNPs)orSilver Nitrates. In commercial items, silver nanoparticles are commonly employed. To better understand the mechanism behind plant responses toAgNPs& to distinguish b/w particle-specific & ionic silver impacts, we investigated the morphological and proteomic alterations caused in Eruca sativa inresponse to AgNPs AgNO3.
UshahraJyoti et al. (2014). Worked on the degradation of rocket seeds. They conducted a comparison examination between seeds and leaves. Their research centered on function of oxidative stress &antioxidantdefense system.
Yuan Zhi et al. (2015) investigated early seedling development in rockets and effects of heavymetals on seed germination. They investigated negative health repercussions for all living forms caused by the buildup of heavy metals in soil and water owing to human activity.
Idress Al Gehani et al. (2016) investigated the development and physiological processes of rockets cultivated in salinity conditions, as well as the effect of soil amendments.
B. Nejadhasan et al. (2017) investigated the germination of rocket seeds under various environmental conditions. He carried out this experiment to see how environmental parameters like as water potential, salinity, temperature, and planting depth affect germination.
Lalit Kishore, Navpreet Kaur, and Randhir Singh (2018) investigated advanced glycation end products, formation of excessive reactive oxygenspecies, &cellularapoptosis, which are implicated in pathophysiology ofdiabetic neuropathy.
Agnese Gugliandolo et al. (2018) conducted research on the seed extract, a wonderful natural substance capable of combating neuroinflammation. This plant contains nutrients that can have a positive impact on your health.
IionaPlaksenkova et al. (2019) investigated the growth and development of rockets as well as the impacts of Fe304 nanoparticles. Plants respond to stress by employing a range of gene regulation systems.
Lovely Mahawar and Gyan Singh Shekhawat (2019) investigated the role of EsHO 1 in reducing NaCl-induced oxidative stress in Eruca sativa seedlings, as well as the relationship between ROS, antioxidants, and HO 1.
Sadia Afsar et al. (2020) assessed salt tolerance in Eruca sativa accessions utilizing morpho-physiological characteristics. The current study aims to examine salt stress tolerance in 25 E. sativa accessions collected from diverse geographical regions in Pakistan.
NajlaAltwaijry et al. (2020). The goal was to examine oxidative stress and testicular toxicity through the therapeutic effect of rocket seeds in therapy.
Francesca Bonvicini et al. (2020) examined the impact of Lactobacillus acidophilus enhanced with rocket seed extracts on the intestinal barrier. Lactic acid bacteria have a favorable influence on intestinal function.
Asif Ullah Khan et al. (2020) conducted research on rocket seed for the manufacture of organic fertilizer. They investigated the favorable impacts on soil characteristics and crop quality. They conducted two field experiments to assess the impact of organic fertilizers on soil fertility.
Binish Khaliq et al. (2021) investigated detailed functional characterisation and structural insights in rockets. A strong napin protein derived from rocket salad seeds has been extensively studied.
Reham M Abd-Elsalam et al. (2021) investigated oxidative stress in rocket seed extract, apoptosis, and the upregulation of Bcl-2 expression. The current investigation was based on an LC/MS analysis of total the ethanol extract in rocket.

Arthur Ferrari Teixeira et al. (2022) investigated the chemicalanalysis of Eruca sativa ethanolic extract & its effects onhyperuricaemia. They found a hypouricaemic response in hyperuricaemic Wister rats treated with ethanoloic extract at a level of 125 mg/kg.
Sheharyar Khan et al. (2022) investigated the influence of osmotic stress on seedgermination, temperature, & seedling development in ErucasativaMill. They concluded that germination models are useful for observing dormancy periods, crop management, and forecasting emergence timeframes.
Maria Cristina Sorrentino et al. (2023) state that ionizingradiation (IR) & its effect onorganisms are increasingly being explored owing to its potentialapplications in grown plants. We investigated effects of ionizing radiation onEruca sativa by examiningplants developed from irradiatedseeds (1 and 10 Gy) under hydroponics. We assessed a variety of morphophysiological parameters as well as genotoxicity. Radiation exposure resulted in significant variation in morphophysiological parameters, indicating lower plant vigor. Shoot length and leaf count were substantially greater in 1 Gy-treated samples, whereas root length was significantly higher in 10 Gy-treated plants. The number of stomata increased considerably with IR exposure, however pigment and Rubisco concentrations decreased due to radiation stress.
Ayşe ÖZKAN et al. (2024) investigated how chitosan treatment affects rocket production and quality. The "Bengi" rocket type was used as a plant stuff, and chitosan was sprayed into the foliage at four different doses (0 (control), 75, 150, and 300 ppm). The yield values were between 1691 and 1914 g m-2, plant height above 24.33 and 27.92 cm, and leaf width between 4.56 and 5.71 cm across all applications. Total dry matter, chlorophyll, total phenolics, vitamin C, and antiradical activity levels ranged from 7.71% to 8.68%, 34.15 and 36.68 SPAD, 104.67 and 180.84 mg 100 g-1, 126.63 and 143.51 mg 100 g-1, and 63.77% and 71.87%, correspondingly.

Material

The materials employed in the current study included three types of ErucasativaL. Plant, which are extensively distributed across our country and the local region of our state (Uttar Pradesh). A brief description of each variety is provided below. Investigations were conducted at the Laboratory of Botany DepaGNTent, MUIT Lucknow.

Local Variety Gargeer (Lvg)

Spherical dark brown seeds, plants from 20 to 100 cm long, strongly sharply lobed leaves with four to ten little peripheral lobes and a large terminal lobe, corymb-shaped flowers 2-4 cm in diameter, petals creamy white or golden purple veined, and stamens yellow.The plant is massively branched. The fruit, a siliqua, is 12-25 mm long and bears an apical beak containing several seeds.

Greater Noida Taramira (Gnt)

Plants range in length from 30 to 120 cm, with deeply pinnately lobed leaves that have six to fourteen little lateral lobes and one huge terminal lobe. Flowers are 2-4 cm in diameter and form a corymb. Petals are creamy white or golden-purple veins, while stamens are yellow. The fruit, a siliqua about 12-25 mm long, contains an apical beak containing many seeds.

Ludhiana Composite Taramira (Lct)

The plant has spherical dark brown seeds, is 20 to 110 cm long, and has deeplypinnately lobed leaves withfour to fourteen little lateral lobes & a broad terminal lobe. The flowersare 2-4 cm in diameter and grouped in corymb. The petals are creamywhite or yellow withpurple lines, &stamens are yellow.The fruit ranges from 12 to 25 mm in length and has an apical beak carrying several seeds.

Figiure 3: Morphological Observations of the Experimental Plant

Figure 4: Process of Hybridization

3. Methodology- Morphological Parameters

Percent Seed Germination

Seed germination trials were conducted at room temperature. 100 seeds from each kind were planted in ten separate petridishes. Blotting paper was placed at the base and soaked with distilled water at regular intervals. There were no fertilizers or chemicals utilized in the soil. On the seventh day following seeding, percentage seed germination was measured.

Seedling Morphology

Seedling morphology was investigated by sowing 200 seeds of each type in various iron trays, filling them with homogeneous soil and irrigating them at regular intervals. To investigate the shape of the hypocotyl, 100 mature seedlings from each variety and F1 intervarietal hybrids were randomly chosen. After the first real leaf appeared, they were removed from the soil. This happened 10 to 15 days after seeding.

At this stage, the seedlings were pressed for a week in a filter paper booklet. The length ofeach seedling's hypocotyl was measuredusing a scale & thread. At the same time, length & breadth of cotyledons weremeasured using a division & scale. Mean cotyledon was scored by multiplying length & breadth of cotyledons.

The relative width of the cotyledon was also determined (breadth / length x 100), and the related standard errors (SE) and coefficient of variation (CV%) were computed. 50 seeds were sown in the field for future research, in addition to those placed in iron trays. Seeds were sowed in rows 25-30 cm apart. The spacing between two rows was approximately 30 cm. The field was watered on a regular basis, and it was constantly monitored. No chemicals or fertilizer were utilized. Seedswere sowed in second week of September in 2022–23. In mature plants, the following morphological traits were studied:

4. Observation and Result Discussion

Percent Seed Germination

In every genetic study, seed weight and germination are considered crucial characteristics. These are quantifiable characteristics. These features are extensively researched in a variety of cultivated plants to determine genetic variability and heritability.

As previously stated, germination tests were conducted under similar environmental circumstances. It was pretty fascinating to see that all the three kinds did not resemble one other in terms of % seed germination and differed greatly from one another. The observed intervarietal variations in percentage seed germination are probably linked to genotypic characteristics.

Table 2:% of Seed Germination of Sample

MATERIALS	**YEAR**	**BASED ON 100 SEEDS IN EACH FORM**		
		MEAN	±S.E.	CV%
GNT	2022	80.3	± .42	1.64
	2023	81.1	±.26	1.01
LCT	2022	80.3	±.27	1.14
	2023	81.4	±.26	1.01
LVG	2022	78.8	±.36	1.51
	2023	79.8	±.26	1.07

The mean difference between all the types is significant at the 1% or 5% level.

Seedling Morphology

Seedlings are young plants that have grown from a seed. It possesses specific morphological traits. The study of seedling morphology is extremely important in both systematic and applied genetics and plant breeding. An attempt was made to analyze two seedling characteristics, namely hypocotyl length and cotyledon area, in the three kinds of Indian rocket. (See figure 6)

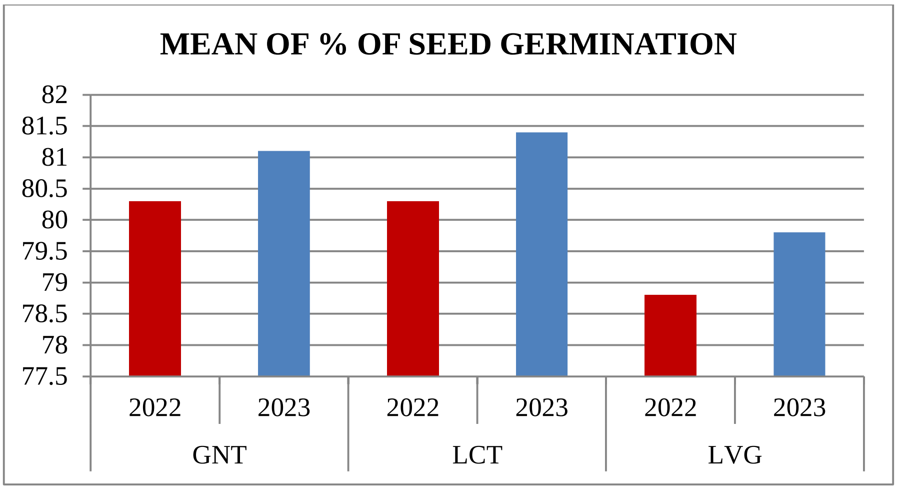

Fig. 5: Mean Of % of Seed Germination of Sample

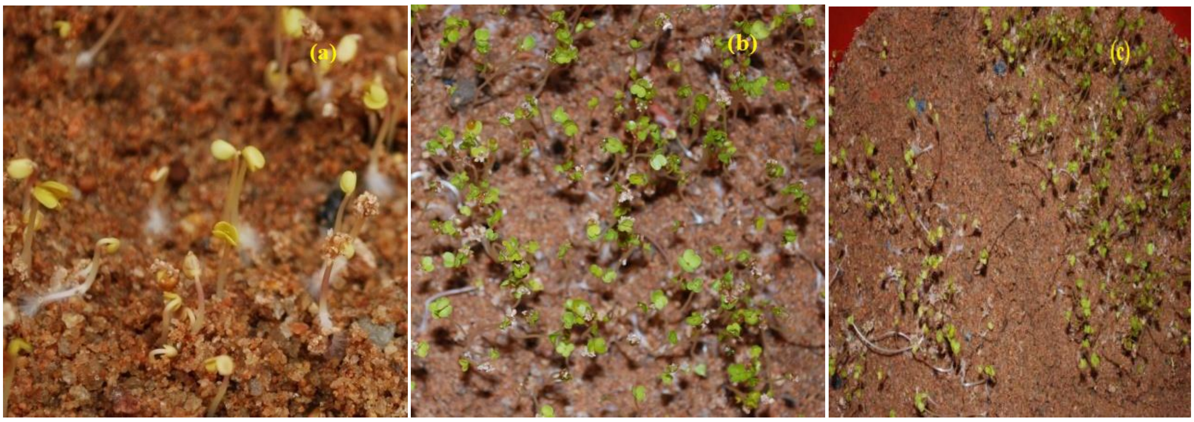

Fig 6: Seedling of Sample and % Seed Germination

Hypocotyl Length

Hypocotyl length was measured in 100 seedlings from each variety, and the findings are shown in Table 3& Figure 7. The data plainly showsthat most of the types vary considerably in mean hypocotyl length.

This measure also shows significant differences across various types. LVG had the shortest hypocotyl, with a mean length of around 4&6 mm in both years of research. LCT and GNT possessed the biggest hypocotyls, measuring 6 and 7 mm in length, respectively.

These types also differed in the co-efficient of variation. GNT and LCT have the largest co-efficients of variation (Table 4.2), whereas LVG has the lowest.

Table 3: Seedling Morphology in Sample (Hypocotyl)

MATERIALS	YEAR	HYPOCOTYL LENGTH (mm)*[a]		
		MEAN	± S.E.	C.V. (%)
GNT	2022	5.5	± .15	9.10
GNT	2023	6.2	± .16	9.18
LCT	2022	5.6	± .16	10.17
LCT	2023	6.4	± .15	7.61
LVG	2022	5.5	± .16	2.96
LVG	2023	6.1	± .21	11

*Based on 100 seedlings in each form.
a. Mean difference of all the varieties GNT, LCT and LVG is significant at 1% or 5% level.

Fig. 7: Different Selected Eruca Plant

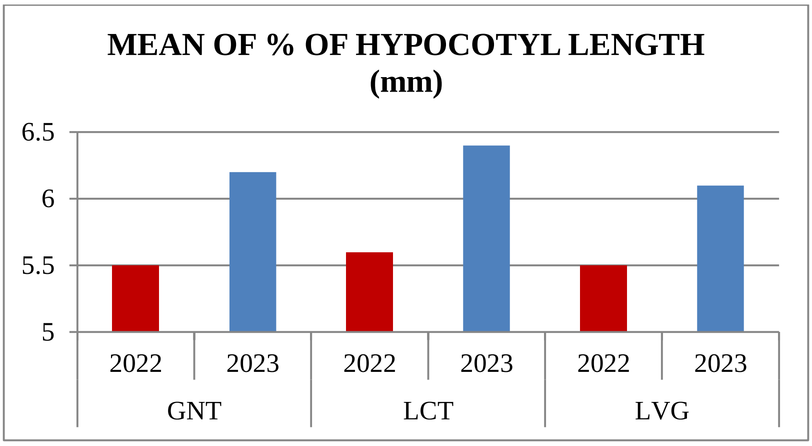

Fig. 8: Mean Hypocotyl Length In Different Varieties Of Eruca Plant

Mean Cotyledon Area

To determine the mean cotyledon area, the length and breadth of the cotyledons in 100 mature seedlings were measured with a divider and scale, then multiplied. The relative length of the cotyledon lamina, or the width-to-length ratio (B/L %), was also investigated. (Table 4) It was discovered that in all variations, the cotyledon breadth was always bigger than the length. LCT had the largest cotyledon, measuring 5 mm, followed by GNT, which had a breadth of 4 mm. LVG has somewhat narrower cotyledons than LCT and GNT, measuring 3 mm. As a result, we can notice a 1mm disparity between various types in this metric.

In terms of cotyledon length, LCT and GNT had the longest, measuring 5 and 4 mm, respectively. LVG exhibited the smallest cotyledon length.

Table 4: Seedling Morphology in Sample (Cotyledon)

MATERIALS	YEAR	MEANCOTYLEDONAREA*[a](mm^2)					
		LENGTH			BREADTH		
		MEAN	± S.E	CV (%)	MEAN	± S.E	C.V.(%)
GNT	2022	4.8	± .24	14.88	8.5	± .15	5.94
GNT	2023	5.6	± .16	14.32	8.4	± .22	8.06
LCT	2022	5.2	± .24	14.32	8.5	± .16	6.28
LCT	2023	5.8	± .24	12.36	9.3	± .18	6.85
LVG	2022	3.7	± .14	11.06	7.5	± .15	6.72
LVG	2023	4.4	± .22	11.07	8.4	± .16	5.77

*Based on 100 seedlings in each form.

a. Mean difference of all the varieties GNT, LCT and LVG is significant at 1% or 5% level.

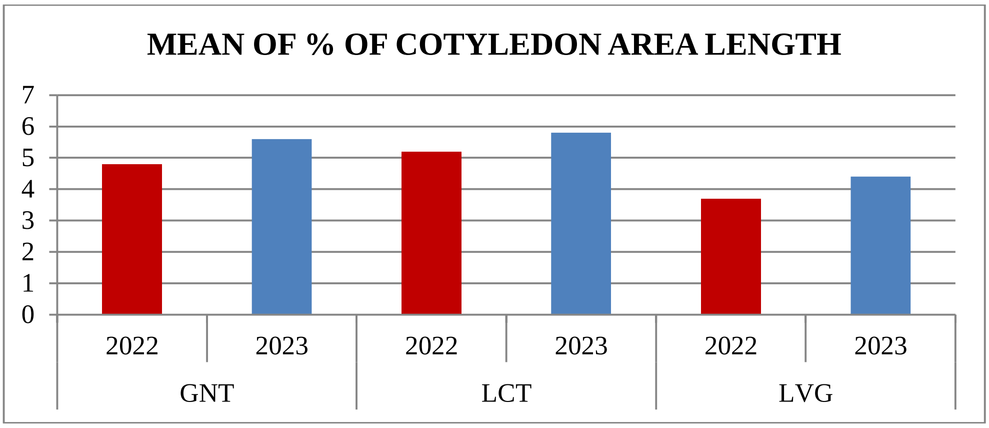

Fig. 9: Mean Cotyledon Area (Length) In Different Varieties of Eruca Plant

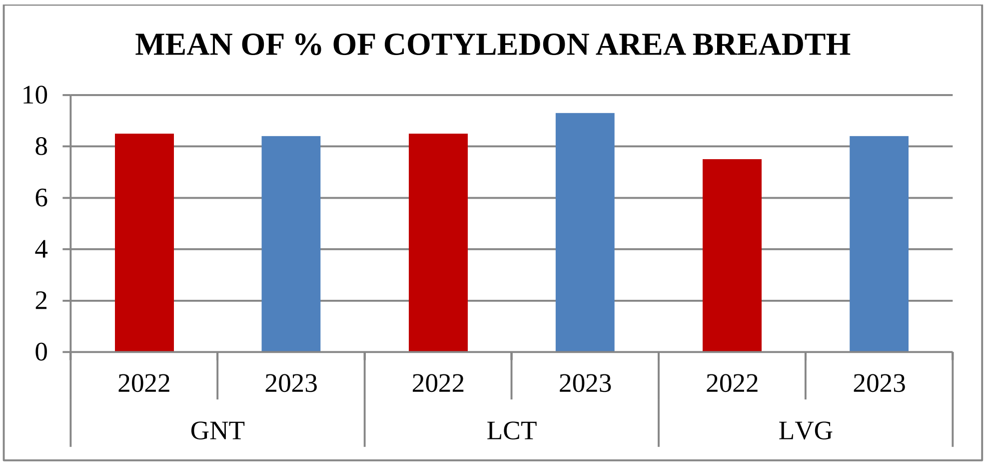

Fig. 10: Mean Cotyledon Area (Breadth) In Different Varieties of Eruca Plant

Although some morphological characteristics of these Indian varieties of Rocket are known and briefly discussed in the previous chapter, some morphological features such as leaf morphology, number of per plant, plant height, & total number of days to appearance of the first flower have not been studied. An comprehensive investigation of these factors over two years revealed significant morphological changes in these types, which may have significant implications in systematic and plant breeding. Aside from it, general features of the plant habit have been noticed.

Comparative Morphophisiological Studies of Different Varieties of Rocket and Their F1 Hybrids Percent Seed Germination

All three cultivars display exceptional stability in terms of % seed germination. As a consequence, a comparative analysis of % seed germination in various types and F1 hybrids was performed, and the findings are shown in Table 5 Fig 11.Germination studies were done under identical environmental conditions. Only 200 seeds from each F1 hybrid were seeded to measure seed germination percentage. The hybrid LCT X GNT had the greatest percentage of seed germination of all the hybrids, 91.64%, followed by LVG X GNT, 90.68%. The hybrid GNT X LCT had the lowest percentage of seed germination (84.42%). The Table shows that all of their F1 intervariatal hybrids, with the exception of LCT X LV.I. andLCT X GNT, had considerably higher mean values than their parental forms. This may be considered an instance of heterosis. GNT × LCT and GNT X L.V.I exhibited similar parental seed germination to GNT and LCT, respectively. These cultivars and their F1 hybrids clearly differed in terms of seed germination percentages. The discrepancies in % seed germination between F1 hybrids may be related to their genotypic characteristics.

Table 5: Comparative Analysis of % Seed Germination in Various Types & F1 Hybrids

NameOfThe Varieties And Hybrids	Seed Germination(%)*A		
	Mean	**±S.E.**	**Cv%**
Lct	81.3	±0.25	1.00
Lct X Lvg	86.4	±0.47	1.73
Lct X Gnt	85.4	±.61	2.28
Gnt	81.1	± .25	1.00
Gnt X Lct	85.1	±.48	1.78
Gnt X Lct	85.9	±.54	1.49
Lvg	79.9	±.27	1.08
Lvg X Lct	86.9	±.31	1.13
Lvg X Gnt	84.8	±.73	2.75

*Based on 100 seeds in each hybrid and variety.

*a. The mean difference in percent seed germination across all hybrids is significant at the 5% level.

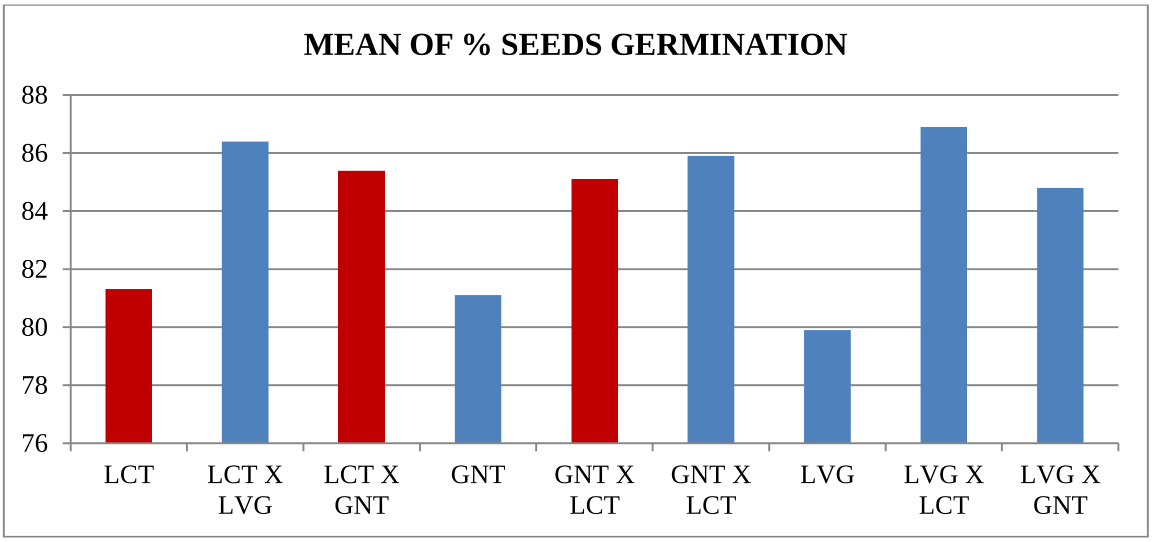

Fig. 11: % Seed Germination in F1 Intervarietal Hybrids and Their Parents

Seedling Morphology in F1 Hybrids

Seedling morphology is an important topic in both systematic and applied genetics and plant breeding research. The seedling characteristics of the three different types of Rocket are quite distinct and may be used effectively in genetic studies. As a result, an attempt was undertaken to analyze primarily two seedling characteristics, hypocotyl length and length, and cotyledon area, in distinct types of the Indian rocket and their three hybrids.

Mean Hypocotyl Length

To investigate hypocotyl morphology, 100 seedlings from each F1 hybrid and their parental forms were measured in length. It is clear that these types and their F1 hybrids vary considerably in mean hypocotyl length (Table 6.Fig. 12). Plants within the types and F1 hybrids also showed significant diversity. It has previously been stated that all three kinds showed exceptional uniformity in mean hypocotyl length. It was fascinating to see that in all three F1 intervariatal hybrids, the mean hypocotyl length was intermediate, falling somewhere between the mean hypocotyl lengths of their parental forms. The mean hypocotyl length in LCT × LVG was similar to LCT × GNT. The table shows that intervarietal hybrids, such as LCT × L.V.I and GNT, have much longer mean hypocotyls than their parental forms, indicating heterosis. Individual plants within the hybrids also showed significant diversity. The hybrid LCT × LVG&GNT. × LCT had the longest hypocotyls, with a mean length of 8 mm. L.V.I × LCT had the smallest, measuring just 5 mm. LCT × GNT ranked second in this metric, with a mean hypocotyl length of 7 mm.

The F1 hybrids also differed significantly in terms of co-efficient of variation. Some F1 hybrids, such as LCT × L.V.I, GNT × LCT, and GNT × LVG, showed higher percent co-efficients of variation than their parental forms. Others had an intermediate value, meaning it fell somewhere between their parental forms.

Mean Cotyledon Area

Another seedling characteristic investigated was the mean cotyledon area. For this, the length and breadth of cotyledons in 100 mature seedlings of various types and F1 hybrids were measured and multiplied. In addition, the relative breadth of the cotyledon was scored.

The breadth of the cotyledon was found to be bigger than the length in all F1s. The data shows that the F1 had substantial differences in mean cotyledon area (Table6, Fig. 13). In all six F1 intervariatal hybrids, the mean cotyledon area was intermediate, falling between the mean cotyledon areas of their parental forms. However, the hybrid LVI &LCT had a considerably greater mean cotyledon area than the parental forms, indicating heterosis. The mean cotyledon area of LCT × GNT was closer to LCT, whereas GNT × L.V.I was closer to GNT. In L.V.I × GNT closer to LVG The hybrid LCT X LVG had the highest mean cotyledon area, followed by LCT × GNT. The hybrid L.V.I × GNT had the lowest mean cotyledon area.

Intervarietal F1 hybrids (LCT × LVI, LCT × GNT, and GNT X L.V.I) outperformed their parental forms in cotyledon mean length.

Table 6: Seedling Morphology in Different Varieties of Rocket And Their F1 Hybrids

MATERIALS	HYPOCOTYLLENGTH(mm)*a			COTYLEDONAREA*b					
				LENGTH			BREADTH		
	MEAN	S.E.	CV%	MEAN	S.E.	CV%	MEAN	SE	CV%
LCT	6.3	±.16	7.61	5.9	±.23	12.37	9.2	±.19	6.84
LCT X LVG	6.8	±.28	13.38	5	±.20	13.2	10	±.33	10.5
LCT X GNT	6.3	± .21	10.63	4.2	±.24	18.57	9.3	±.25	8.81
GNT	6.1	±.17	9.18	5.7	±.15	14.31	8.3	±.21	8.07
GNT X LCT	6.9	±.17	8.11	4.8	±.19	14.65	9.8	±.24	7.95
GNT X LVG	7.5	±.16	6.93	5.6	±.26	15	10.6	±.30	9.05
LVG	6	±.20	11	4.3	±.21	11.08	8.3	±.15	5.78
LVG X LCT	4.6	± .21	15	4.8	±.24	16.25	9.7	±.21	6.90
LVG X GNT	5.4	±.21	12.77	5.5	±.16	9.45	10.7	±.33	9.81

*Based on 100 seedlings in each form.

*a. The mean difference between the hybrids is significant at the 1% or 5% level. The mean difference between all hybrids and their parents is significant at the 5% level.

*b. The mean difference between all hybrids is statisticallysignificant at 1% or 5% level. The mean difference b/w all hybrids and their parents is considerable.

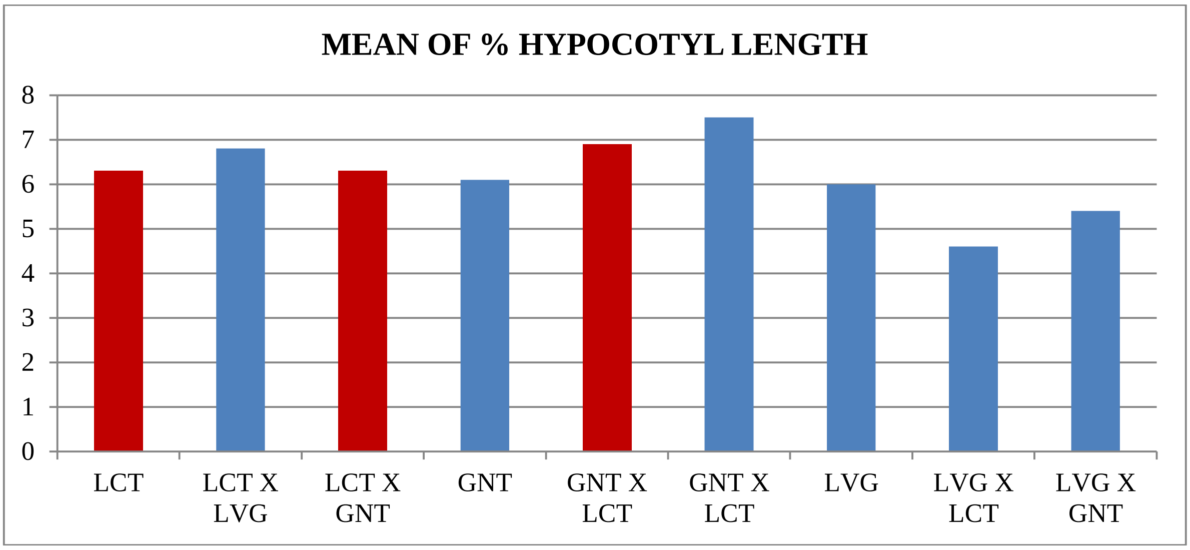

Fig. 12: Mean Of Hypocotyl Length

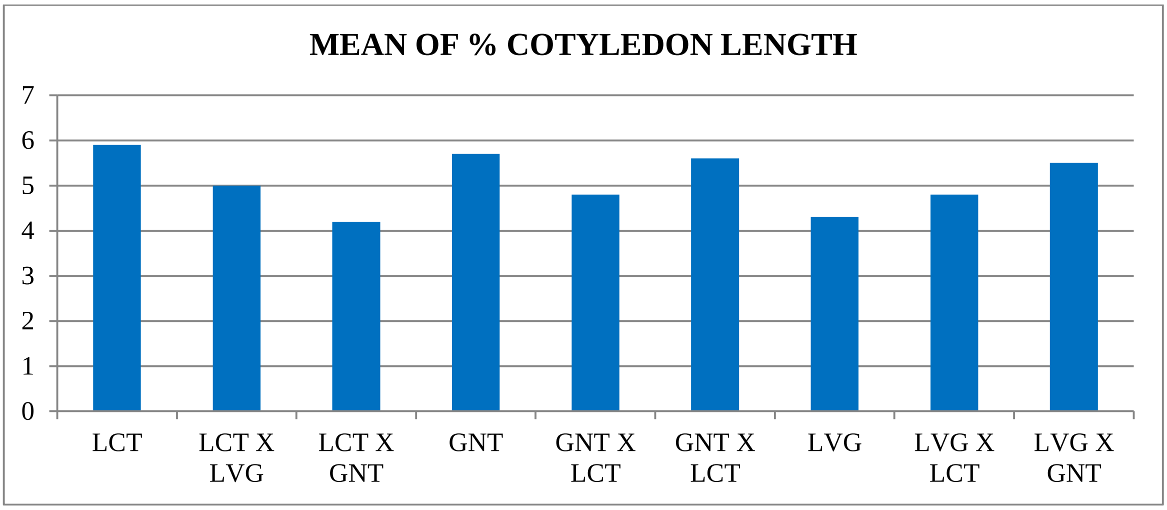

Fig. 13: Mean Cotylydon Length

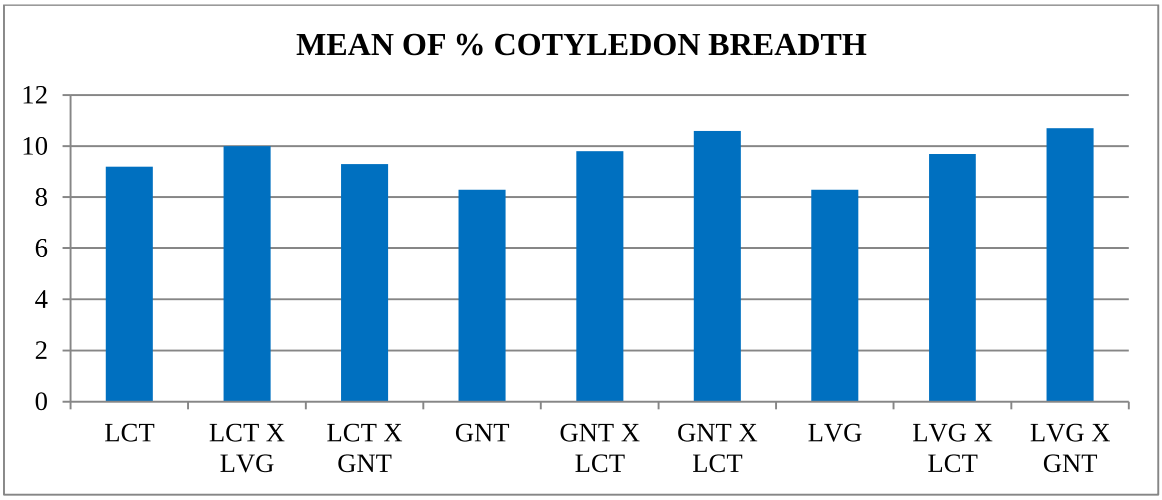

Fig. 14: Mean Cotylydon Breadth

Certain morphological traits may be very important in both systematic and applied genetics in plant breeding. As a result, three important morphological characters were investigated in the varieties and their F1 hybrids: leaf morphology, specifically number of leaves per plant, number of leaf lobes, number of branches per plant, plant height, & total number of days until the appearance of the first flower. A comparative description of the above-mentioned morphological trait is offered.

5. Conclusions

The rocket varietal populations under study differ genotypically in a variety of morpho-physiological characteristics: Percentage seedgermination Mean hypocotyllength, mean cotyledonarea and relative cotyledon width.The current study considers many morphological characteristics. The goal of the research is to achieve heterosis through hybridization. The following parameters were evaluated during the current investigation:

Seedling morphology was investigated by planting 200 seeds of each type in separate iron trays, filling them with uniform soil, and irrigating them at regular intervals. 100 mature seedlings of each variety and F1 intervarietal hybrids were chosen at random to investigate hypocotyl morphology. At the same time, length & breadth of cotyledons weremeasured using a division & scale. The mean cotyledon was determined by multiplying length & breadth of cotyledons. The rocket varietal populations studied here differ genotypically in a variety of morpho-physiological characteristics. F1 intervarietal hybrids outperform their parents in all morpho-physiological characteristics, which can be regarded an example of heterosis due to enhanced heterozygosity.

6. References

1. Blamey, M. & Grey-Wilson, C. (1989). Flora of Britain and Northern Europe. ISBN 0-340-40170-2.
2. Yaniv, Zohara; Schafferman, D.; Amar, Z. (1998). "Tradition, Uses and Biodiversity of Rocket (Eruca sativa, Brassicaceae) in Israel". Economic Botany. 52 (4): 394–400. Doi: 10.1007/BF02862069. JSTOR 4256115. S2CID 36181033.
3. Vilamil, J. M. P. (2002). Time of seed collection and germination in rocket, Erucavesicaria (L.). Genetic Resources and Crop Evolution 45, 47-51.
4. Sastry, EV. (2003). Improvement in Eruca sativa L. Aricultural Reviews, 24(4), 235-249.
5. Mahmood, S. ET. al. (2004). Comparative performance of Brassica napus and Eruca sativa under water deficit conditions: An assessment of selection criteria. J. Res. Sci, 14(4), 439-446.
6. Barillari, J. ET. al. (2005). Direct antioxidant activity of purified glucoerucin, the dietary secondary metabolite contained in rocket seeds and sprouts. Journal of Agriculture and food chemistry, 53(7), 2475- 2482.
7. Sun-Ju Kim and GenshoIshii (2006) investigated antioxidant &glucosinolate profiles of rocket salad seeds, leaves, and roots. Rocket salad yielded a substance known as methoxyglucobrassicin.
8. Alam, S. M. ET. al. (2007). Eruca sativa seeds possess antioxidant activity and exert a protective effect on mercuric chloride induced renal toxicity. Food and chemical toxicology, 45(6), 910-920.
9. Nielsen, T., Bergstorm, B., &Borch, E. (2008). The origin of off – odours in packaged rucola. Food chemistry, 110(1), 96-105.

10. Khan, S. &Qurainy. F. Al. (2009). Mutagenic effect of sodium azide on seed germination of Eruca sativa (L.). Australian Journal of Basic and Applied Sciences 3(4), 3081-3087.
11. Ozdener, Y. &Ayadin, B. K. (2010). The effect of zinc on the growth and physiological and biochemical parameters in seedling of Eruca sativa L. ActaPhysiologiaePlantarum , 32(3), 469-476.
12. Kasem, WT., Ghareeb, A., &Marwa, E. (2011). Seed morphology and seed coat sculpturing of 32 taxa of famiyBrassicaceae. Journal of American science, 7(2), 166-178.
13. Al-Whaibi, H. M. ET. al. (2012). Influence of plant growth regulators on growth performance and photosynthetic pigments status of Eruca sativa Mill. Journal of Medicinal Plants Research, 6(10), 1948 – 1954.
14. Vannini, C. ET. al. (2013). Morphological and proteomic responses of Eruca sativa exposed to silver nanoparticles of silver nitrate. Plos one, 8(7), 68752.
15. Jyoti, U. & Malik, C.P. (2014). Seed deterioration in Eruca sativa (Miller) Thell. Varieties: Comparative factors between seeds and leaves. International Journal for Research in Applied Science and Engineering Technology, 2(11), 203-214.
16. Zhi, Y. ET. al. (2015). Influence of heavy metals on seed germination and early seedling growth in Eruca sativa Mill. American Journal of Plant Sciences, 6(05), 582.
17. Gehani, AL. I., Ismail, T. (2016). Effect of soil amendment on growth and physiological processes of rocket grown under salinity conditions. Australian journal of basic and applied sciences, 10(1), 15-20. Genetica 39, 1-24.
18. Nejadhasan, B. ET. al. (2017). Studying the response of seed germination of neglected plant arugula to some environmental factors. Journal of plant production 24(2), 77-91.
19. Kishore, L., Kaur, N., & Singh, R. (2018). Effect of kaempferol isolated from seeds of Eruca sativa on changes of pain sensitivity in streptozotocin-induced diabetic neuropathy. Inflammopharmacology, 26 (4), 993-1003.
20. Gugliandolo, A. ET. al. (2018). Eruca sativa seed extract: A novel natural product able to counteract neuroinflammation. Molecular Medicine Reports, 17(5), 6235 – 6244.
21. Plaksenkova, I. ET. al. (2019). Effects of Fe304 nanoparticle stress on the growth and development of rocket. Journal of nanomaterials, 2019.
22. Mahawar, L., &Shekhawat, S. G. (2019). EsHO 1 mediated mitigation of NaCl induced oxidative stress and correlation between ROS, antioxidants and HO 1 in seedling of Eruca sativa. Physiology and Molecular Biology of Plants, 25(4), 895 -904.
23. Afsar, S. ET. al. (2020). Evaluation of salt tolerance in Eruca sativa accessions based on morpho- physiological traits. Peer J, 8, e9749.
24. Altwaijry, N. ET. al. (2020). Therapeutic effects of rockets seeds against testicular toxicity and oxidative stress caused by silver nanoparticles injection in rats. Environmental toxicology, 35(9), 952-960.
25. Bonvicini, F. ET. al. (2020). Effect of Lactobacillus acidophilus fermented broths enriched with Eruca sativa seed extracts on intestinal barrier and inflammation in a co-culture system. Nutrients 12(10), 3064.
26. Khan, U. A. ET. al. (2020). Production of organic fertilizers from rocket seed, chicken peat and Moringaolifera leaves for growing linseed under water deficit stress. Sustainability, 13(1), 59.
27. Binish Khaliq et al. (2021) investigated detailed functional characterisation and structural insights in rockets. A strong napin protein derived from rocket salad seeds has been extensively studied.

28. Reham M Abd-Elsalam et al. (2021) investigated oxidative stress in rocket seed extract, apoptosis, and the upregulation of Bcl-2 expression. The current investigation was based on an LC/MS analysis of total the ethanol extract in rocket.
29. Teixeira, A. F. ET. al. (2022). Chemical analysis of Eruca sativa ethanolic extract and its effects on hyperuricaemia. Molecules, 27(5), 1506.
30. Khan, S. ET. al. (2022). Quantifying temperature and osmotic stress impact on seed germination rate and seedling growth of Eruca sativa Mill. Life 12(3), 400.
31. Maria Cristina Sorrentino et al. (2023)"Evaluation of morpho-physiological responses and genotoxicity in Eruca sativa (Mill.) grown in hydroponics from seeds exposed to X-rays" PeerJ. 2023; 11: e15281. Published online 2023 Apr 26. doi: 10.7717/peerj.15281 PMCID: PMC10148638 PMID: 37128204.
32. ÖZKAN, AYŞE and ÜNLÜ, HALİME (2024) "Chitosan application improves yield and quality of rocket (Eruca sativa)," Turkish Journal of Agriculture and Forestry: Vol. 48: No. 2, Article 11. https://doi.org/10.55730/ 1300-011X.3181 Available at: https://journals.tubitak.gov.tr/agriculture/vol48/iss2/11.