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Research Article

Study of morphological parameters and germination index of *Trigonella foenum-graecum* L.

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ABSTRACT

Fenugreek (*Trigonella foenum-graecum* L.), plant is widely distributed throughout the world and which belongs to the family Fabaceae. Fenugreek (*Trigonella foenum-graecum* L.), is an annual herb. Morphological parameters of Fenugreek (*Trigonella foenum-graecum* L.) was observed that the shoot length of seedling (3.408 cm) and root length of seedling (2.583 cm). Fresh weight of seedling of root and shoot were recorded (0.834 and 0.119 gm.) and dry weight of seedling were found approximately eight time less (0.111 and 0.010 gm.) than the fresh weight of seedling. Vigor index of Fenugreek were found (560.064) and moisture content was (0.792). Stomatal index of abaxial side was more (12.671) than the number of stomatal index on adaxial side (10.011). The germination percentage of seeds was (96.774 %). The percentage of seed germination was higher (100 %) in 10 ppm and 20 ppm of IAA and KI, comparatively the period seeds took for germination is very shorter (two days). The percentage of seed germination was low (20 %) in 30 ppm of (2, 4-D) after five days, (50 %) in 20 ppm of (2, 4-D) after five days, (70 %) in 30 ppm of (2, 4-D) after five days.

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INTRODUCTION

All human beings required a number of complex organic/inorganic compounds in diet to meet the need for their activities. The important constituents of diet are carbohydrates, fats, proteins, vitamins, minerals and water (Indrayan *et al.*, 2005). According to New Wall *et al.* (1996), every constituent plays an important role and deficiency of any one constituent may lead to abnormal developments in the body. Plants are the rich source of all the elements essential for human beings. Since the beginning of human civilization plants have been used as one of the most important sources of medicine. In spite of tremendous development in the field of allopathy, plants still form one of the major sources in the modern as well as traditional medicine throughout the world. India is storehouse of medicinal plants. About 70% of rural folk depends on medicinal plants for their health care therefore now a days much attention is being paid to the utility and development of plants and to study their medicinal properties.

Morphological and anatomical characters of plants play vital role in the study of crude drug. Standardization, morphological characters involve size, arrangement, venation, texture, surface characters etc. (Metcalfe and Chalk, 1957). The phytochemical constituents and medicinal

properties of most of the medicinal plants were recorded in the last decades by a number of workers (Nadkarni, 1976, Nudrat and Usha, 2005). Developing countries uses more than 80% traditional medicines for primary healthcare. (Farnsworth, N. and Soejarto, 1991) The herbal medicines are in global demand. (Srivastava, 2000). In India, the Ayurvedic medicines are estimated in market level at 20% annually (Subrat, 2002).

MATERIALS AND METHODS

The plant materials of *Trigonella foenum-graecum* collected from our botanical garden, during different seasons viz. summer, monsoon and winter. The leaves stem, root and seeds samples are collected and kept separately. Morphological parameters includes, Length of seedling (root, shoot and total length), fresh and dry weight of seedling (root, shoot and total weight), moisture content of seedling and stomatal index were also determined.

Germination % was determined by petri plate method. Seeds were germinated in petri dishes containing filter paper soaked in glass distilled water. Sufficient amount of distilled water was added so that it maintained constant moisture. Then 100 seeds of each material kept in petri plates. All the petri plates kept in such a way that they maintain pure and

equal amount of light. Then seeds were kept for germination and petri plates were regularly observed for moisture content. Germination of seeds was recorded for 5-7 days depending upon species after every 24 hours. And seeds were considered germinated when the radical became visible. Germination indices i.e. total germination (Also known as final germination percentage) (GT), speed of

germination (S), Speed of accumulated germination (AS), coefficient of the rate of germination (CRG), mean germination time (MGT), speed of germination index (SGI), vigour index (VI) were calculated as described in table 1. Effect of chemicals and plant hormones (IAA, KI, 2-4-D, NAA) of various concentrations (10 , 20 and 30 ppm) were also observed by petriplate methods.

Table No. 1

Sr.No.	Germination index	Formula
1.	Total germination (final germination percentage)(GT)	$GT = \frac{NT \times 100}{N}$ NT: Proportion of germinated seed in each treatment for the final measurement N: Number of seed used in Bioassays
2.	Speed of germination (S)	$S = (N_1 \times 1) + (N_2 - N_1) \times \frac{1}{2} + (N_3 - N_2) \times \frac{1}{3} + \dots (N_n - N_{n-1}) \times \frac{1}{n}$ N₁, N₂, N₃, N_{n-1}, N_n: Proportion of germinated seeds observed at first, second, third..... (n - 1), (n) days or hours
3.	Speed of Accumulated germination (AS)	$AS = [N_1 / 1 + N_2 / 2 + N_3 / 3 + \dots + N_n / n]$ N₁, N₂, N₃, N_n: Cumulative number of seed which germinate on time 1, 2, 3....., N
4.	Coefficient of the rate of germination (CRG)	$CRG = \frac{[N_1 + N_2 + N_3 + \dots + N_n] \times 100}{(N_1 \times T_1) + (N_2 \times T_2) + (N_3 \times T_3) + \dots (N_n \times T_n)}$ N₁: Number of germinated seeds at time T₁ N₂: Number of germinated seeds at time T₂ N_n: Number of germinated seeds at time T_n
5.	Mean germination time (MGT)	$MGT = \frac{N_1 + (N_2 - N_1) + (N_3 - N_2) + \dots (N_n - 1 - N_n)}{T_1 + T_2 + T_3 + \dots T_n}$ N₁, N₂, N₃ N_n are no. of germinated seeds on T₁, T₂, T₃..... T_n days
6.	Speed of germination Index (SGI)	$SGI = (7 \times N_1) + (6 \times N_2) + (5 \times N_3) + (4 \times N_4) + (3 \times N_5) + (2 \times N_6) + (1 \times N_7)$ N₁, N₂, N₃..... N₇ are no. of germinated seeds on 1st, 2nd, 3rd.... 7th days resp.
7.	Vigor Index (VI)	$(VI) = [\text{seedling length (cm)} \times \text{germination percentage}]$

RESULTS AND DISCUSSION

i) Determination of morphological parameters:

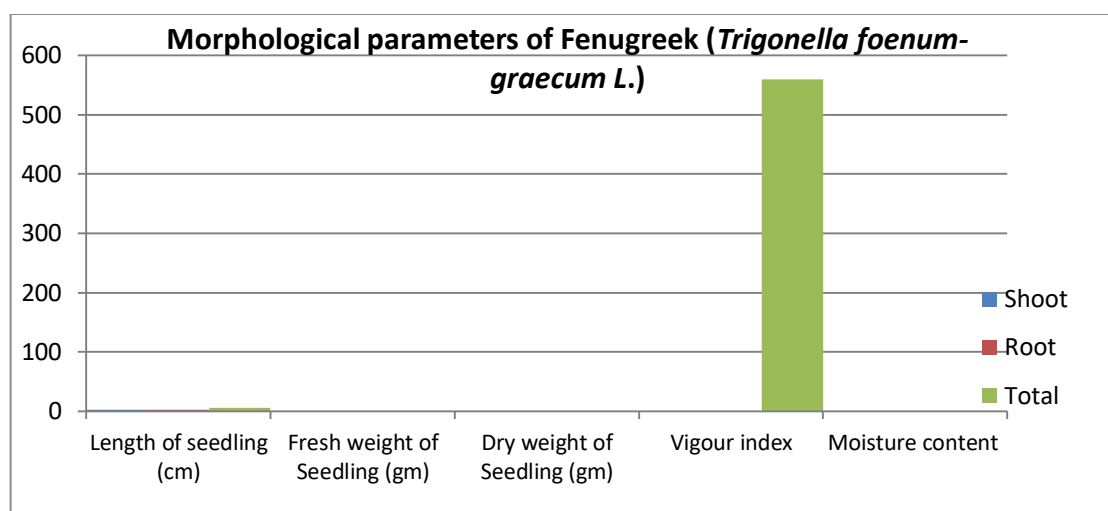
Plant morphology examines the pattern of development, the process by which structures originate and mature as a plant grows. The way in which new structures mature may be affected by the point in the plants life when they begin to develop, as well as by the environment to which the structure are exposed.

(Table No.2 and Graph No.1) shows the morphological parameters of Fenugreek (*Trigonella foenum-graecum* L.). It was observed that the shoot and root length of seedling was

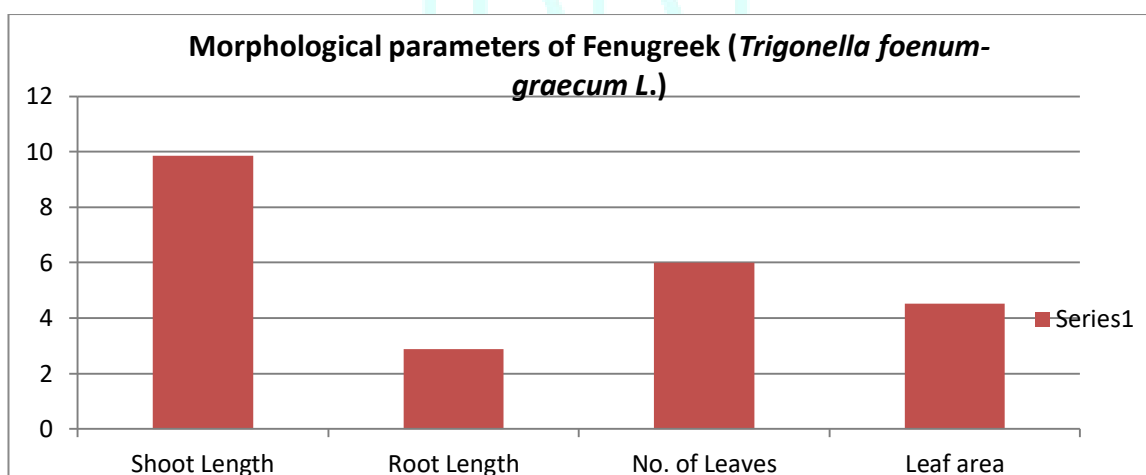
(3.407, 2.582) respectively. Fresh weight of seedling of root and shoot were recorded (0.834 and 0.119), But dry weight of seedling were found approximately eight time less (0.110 and 0.010) than the fresh weight of seedling. Vigor index of Fenugreek (*Trigonella foenum-graecum* L.) were found (560.064) and moisture content was (0.792). (Table No.2. and Graph No.1) shows the morphological parameters of Fenugreek (*Trigonella foenum-graecum* L.). It was observed that the shoot length was almost triple (3.408) than the root length (2.583). It was observed that number of leaves and leaf area was (6.000) and (4.530) respectively (Table No. 3 and Graph No.2).

Table No. 2 Morphological parameters of Fenugreek (*Trigonella foenum-graecum* L.)

Length of seedling (cm)			Fresh weight of Seedling (gm.)			Dry weight of Seedling (gm.)			Vigor index	Moisture content
Shoot	Root	Total	Shoot	Root	Total	Shoot	Root	Total		
3.408	2.583	5.991	0.835	0.120	0.955	0.111	0.010	0.121	560.064	0.792

Graph No. 1: Morphological parameters of Fenugreek (*Trigonella foenum-graecum* L.)**Table No. 3 - Morphological parameters of Fenugreek (*Trigonella foenum-graecum* L.)**

Shoot Length	Root Length	No. of Leaves	Leaf area
9.850	2.875	6.000	4.530

Graph No. 2: Morphological parameters of Fenugreek (*Trigonella foenum-graecum* L.)**ii) Determination of stomatal index:**

Plant stomata, the vital gate between plant and atmosphere may play a central role in plant responses to environmental conditions, which have been and are being investigated from molecular and whole plant perspectives, as well as at ecosystem and global level (Nilson and Assmann, 2007). Among the environmental factors affecting plant activity, light quality is one of the most important factors regulating the stomata movements (Willmer and Fricker, 1996).

Table No. (4) Showed the stomatal parameters of Fenugreek (*Trigonella foenum-graecum* L.). Abaxial epidermal cells are more (64.345) than the adaxial side of epidermal cell (61.754). Number of stomata on abaxial side was found to be more (12.478) than the number of stomata on adaxial side (9.852). Stomatal index of abaxial side was more (12.671) than the number of stomatal index on adaxial side (10.011).

Table No. 4 - Stomatal index of Fenugreek (*Trigonella foenum-graecum* L.)

No. of Epidermal Cells		No. of Stomata		Stomatal Index	
Adaxial Side	Abaxial Side	Adaxial Side	Abaxial Side	Adaxial Side	Abaxial Side
61.754	64.345	9.852	12.478	10.011	12.671

iii) Determination of Germination Index:

Germination is an appropriate stage in the life of plants; it is the first step towards survival and is usually controlled by a complex combination of environmental factors. Seed germination and seedling growth has been widely accepted as main parameters to monitor growth responses owing to amendment. In several fields including photobiology, germination bioassays are in wide use to assess the effectiveness designed treatments. Mostly the maximum percentage germination is considered sufficient for interpretation, which depends only on final results. In this study six germination indices i.e. total germination (also known as final germination percentage) (GT), Speed of germination (S), Speed of accumulated germination (AS), Coefficient of the rate of germination (CRG), Mean germination time (MGT) and Speed of germination index

(SGI) were calculated from the data to evaluate their effectiveness in data interpretation. Percentage germination do not provide sufficient information on photo biological effect on plants.

Objectives of the present study were to calculate germination indices from the data to evaluate better ways of using these indices in order to improve the precision in seed germination bioassays. (Table No 5) shows germination in Fenugreek (*Trigonella foenum-graecum* L.). The germination percentage of seeds was (96.774 %). According to data, it was observed that there is no significant different in three replication of percentage of germination. The speed of germination, speed of accumulated germination, coefficient of the rate of germination, mean germination time, speed of germination index and vigor index were (21.210, 39.904, 32.200, 3.030 and 370.000) respectively (Table No.5).

Table No. 5) - Determination of Germination Index

GT (%)	S	AS	CRG	MGT	SGI
96.774± 1.145	21.210± 0.270	39.904± 0.565	32.200± 0.007	3.030± 0.000	370.000± 4.532

GT (%) – Total germination %, S – Speed of germination, AS – Speed of accumulated germination, CRG – Coefficient of the rate of germination, MTG – Mean germination time, SGI – Speed of germination index.

iv) Effect of different hormones and chemicals on germination index:

Four growth hormones and chemicals were afforded to study their effects on the germination of seeds of Fenugreek (*Trigonella foenum-graecum* L.). In each treatment, ten seeds were set for germination. In 10 ppm and 20 ppm of auxin (IAA), 10 seeds germinated after two days and its percentage of seed germination was 100 % (SGP2100). In 30 ppm of auxin (IAA), 10 seeds germinated after five days and its percentage of seed germination was 100 % (SGP5100). In 10 ppm and 20 ppm of Potassium iodide (KI), 10 seeds germinated after two days and its percentage of seed germination was 100 % (SGP2100). In 30 ppm of auxin (IAA), 10 seeds germinated after three days and its percentage of seed germination was 100 % (SGP3100) (Table No.6).

In 10 ppm of (2, 4-D), 07 seeds germinated after five days and its percentage of seed germination was 70 % (SGP570).

In 20 ppm of (2, 4-D), 05 seeds germinated after five days and its percentage of seed germination was 50 % (SGP550) and compared with distilled water. In 30 ppm of (2, 4-D), 02 seeds germinated after five days and its percentage of seed germination was 20 % (SGP520). In 10 ppm and of (NAA), 08 seeds germinated after five days and its percentage of seed germination was 80 % (SGP580). In 20 ppm of (NAA), 09 seeds germinated after five days and its percentage of seed germination was 90 % (SGP590). In 30 ppm of (NAA), 10 seeds germinated after three days and its percentage of seed germination was 100 % (SGP5100) (Table No.6).

The percentage of seed germination was higher (100 %) in 10 ppm and 20 ppm of IAA and KI, comparatively the period seeds took for germination is very shorter (two days). The percentage of seed germination was low (20 %) in 30 ppm of (2, 4-D) after five days, (50 %) in 20 ppm of (2, 4-D) after five days, (70 %) in 30 ppm of (2, 4-D) after five days (Table No.6).

Table No. 6- Effect of different hormones and chemicals on germination index.

Sr. No.	Chemicals / Growth hormones	Conc. in ppm.	Total seeds put for germination	Days of germination				Number of seeds germinated	Percentage of seed germination
				2	3	4	5		
1	IAA	10	10	10	-	-	-	10	100%
		20	10	10	-	-	-	10	100%
		30	10	07	02		01	10	100%
2	KI	10	10	10	-	-	-	10	100%
		20	10	10	-	-	-	10	100%
		30	10	08	02	-	-	10	100%
3	2,4-D	10	10	-	04	01	02	07	70%
		20	10	-	02	02	01	05	50%
		30	10	-	-	-	02	02	20%
4	NAA	10	10	-	04	02	02	08	80%
		20	10	-	06	01	02	09	90%
		30	10	-	05	02	03	10	100%
5	Control (D.W.)	--	10	10	-	-	-	10	100%

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