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Original Research Paper

Response of *Ipomoea carnea* Jacq. to the Organic Matter and Water Content of Soils

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ABSTRACT

Ipomoea carnea, Jacq. is an exotic weed distributed in tropical countries of Asia and America. In India it is a common weed in field and has probably got introduced along with cultivation. The species is recognized well all over India, particularly along the bunds of agricultural fields. It is a localized weed and wherever it grows it dominates over the associate species. A general survey of vegetation showed that this species formed pure or mixed stands in practically all types of habitats common in an urban environment, revealing its wide ecological amplitude. The plant species, though of common distribution in countryside, shows luxuriant growth within the city, especially near slums or hutment, where deposition of undecomposed organic matter and domestic waste are rampant. Likewise, luxuriant plant growth is also observed on toxic waste, water logged ground and sometimes, even on dry soils. Its gregarious and cosmopolitan distribution reflects on its inherent ability to either circumvent or overcome the adversity itself. It appears, therefore, that urbanization has been a spent force in so far as *Ipomoea carnea* is concerned. The organic matter in soils originates from green plants, animals and microorganisms. The nature of organic matter is governed by inputs and soil metabolism. Chemically, the soil organic matter is a potential source of N, P and S for plant growth and it aids in rendering available soil Ca, Mg, Fe and P. Humic colloidal substances function for base-exchange capacity of soil. Organic matter also functions as a source of CO_2 for the higher plants. Water content of soil exerts a profound effect upon the form and structure of a plant. It is well known that compaction of soil can greatly restrict root proliferation particularly when the soil is low in water content. The yield of plant may also be affected by deficiency of water, even though the soil is not allowed to dry to permanent wilting point. Water stress also affects leaf area through hastening the senescence. Present paper deals with response of *Ipomoea carnea* to different levels of organic matter and water contents of soils.

INTRODUCTION

Water content of soil exerts a profound effect upon the form and structure of a plant. Steokel (1968) showed that plant growth with less irrigation fared poorly as compared to that with natural precipitation or regularly irrigated plants. Devis (1940) grew corn plants in soil cultures in green-house and measured the rate at which plants increased in height at different water percentages in the soil. He found that the rate of growth increased with water content of the soil. The yield of plants may also be affected by deficiency of water, even though the soil is not allowed to permanent wilting point (Wedleigh 1946). One special aspect of root growth deserve mentioned about mechanical impedance offered by a soil. It is well known that competition of soil can greatly restrict root proliferation particularly when the soil is low in water content (Pearson 1966). Relation between long term growth or crop yield and water stress are often studied only empirically (Salter & Goode 1967). Water stress also affects leaf area through heatening the rate of senescence (Slatyer 1973, Ludlow 1975).

The organic matter in soil originates from green plants, animals and microorganisms. It is essentially a transient constituent; new supplies are being continuously added, while the old material is being continuously decomposed. The nature of organic matter is governed both by inputs and soil metabolism. Consequently, vegetation, climate, parent material and topography, all have a strong influence on organic content of soil.

The physical effects of organic matter on soil are very complex. However, the effects have qualitative significance in connection with weight, cohesion, structure, porosity, colour and temperature of soil. Organic matter affects water content directly by retaining water in large amounts on the extensive surfaces of its colloidal constituents and holding it like a sponge in its less decayed portion. Organic matter helps in conservation of soil nutrients by preventing erosion and surface runoff of nutrients.

Chemically, the soil organic matter is a potential source of N, P and S for plant growth, it aids in rendering available soil Ca, Mg, Fe and P, and humic colloidal substances function for base-exchange capacity of soil. Organic matter also functions as a source of CO_2 for higher plants. Furthermore, the rare elements that are commonly present in plants probably play an important role in nutrition as they are rendered available through decomposition.

The biological importance of soil organic matter is indicated by the fact that it influences growth and development of soil microorganisms by affecting a more favourable physicochemical environment. Microorganisms decompose organic matter and render available nitrogen and other elements that are essential as plants nutrients.

Various chains of special beneficial effects of soil organic matter on plant growth have been advanced from time to time. Bottomley (1914, 1917) found that small quantities of organic substances extracted from microorganisms stimulated plant growth. Breazeale (1927) indicated that plants required small quantities of certain organic substances for normal growth. Natural humic acid of soil increases growth of various higher and lower plants. Several organic substances, which are present in organic matter, have been found to stimulate plant growth.

The most important difference between habitats is directly or indirectly due to differences of water content of the habitats. It was seen that distribution of *Ipomoea carnea* in urban areas was related to water and organic contents of soils, and hence, its luxuriant growth in flooded and organically rich areas. To verify this affinity further, a series of laboratory experiments were conducted, findings of which are presented in this research paper.

MATERIALS AND METHODS

Response of *Ipomoea carnea* to different levels of soil water content. *Ipomoea carnea* plants were brought and their stem outrings of uniform length (20 cm) were planted. Five individuals were planted in each pot. Watering was done every day, 2^{nd} day, 3^{rd} day, 4^{th} day and 5^{th} day using 500 mL water at a time. All the treatments were given in triplicate. The following parameters were studied after harvesting the plants on 61^{st} day.

Shoot length: The maximum length of each shoot was recorded in cm and mean shoot length per individual plant at a site was calculated.

Shoot diameter: Diameter of shoot (as represented by the fifth internode from the apex) in cm of individual plants was noted and mean diameter was calculated.

Area of fifth leaf: For finding the area of leaf, formula suggested by Kemp (1960) was used.

$A = (L \times B)/K$, $K = \dfrac{L \times B}{A}$

Where, A = Graphical area of leaf in cm^2
L = Length of leaf in cm
B = Breadth of leaf in cm
K = Leaf factor

In order to find out the value of 'K' areas of twenty leaves were measured by tracing them on graph paper. Length and breadth were noted.

$$K = \frac{\text{Length} \times \text{Breadth}}{\text{Area of leaf measured by graph paper}}$$

The mean of twenty 'K' values was taken. The value thus obtained was found to be 1.44 for *I. carnea* (Table 1).

Shoot dry weight: Plants were dried at 70 ± 1°C till dry and their dry weight was recorded as g/plant.

Micromorphology: The observations were made on peelings of the central zone on the lower epidermis of the 5th leaf from the top, stained in dilute saffranin and mounted in 50% glycerin. The parameter studied were:

1. Stomatal density: Number of stomata was counted with the help of an occulometer on a calibrated microscope and expressed as number of stomata per 0.25 mm^2.
2. Stomatal index (SI): The stomatal index was calculated by the formula suggested by Salisbury (1927).

$$SI = \frac{S}{F + S} \times 100$$

Where, S = Number of stomata in field.

F = Number of epidermal cells in the same field.

3. Size of stomata: Length and breadth of stomatal aperture were measured with the help of micrometer and recorded.

For all the micromorphometric observations twenty readings were taken and a mean value was calculated.

Total Chlorophyll content: Chlorophyll content was estimated by the method given by Arnon (1949) as modified by Maclachlan & Zalik (1963). Chlorophyll values were expressed as mg/g fresh weight of leaves.

$$\text{Total chlorophyll mg/g fresh Weight} = \frac{20.2D645 + 8.02D660}{d \times 1000 \times w} \times V$$

Where,

D = Optical density reading of chlorophyll extract at specific wavelength
V = Final volume of 80% acetone extract
d = Path of light length in cm
w = Fresh in weight in g of the tissue extracted

Response of *I. carnea* to different levels of organic manure in soil: *Ipomoea carnea* plants were cut into 20 cm stems and grown in soil and organic manure mixture. The latter representing organic matter. Each pot contained five individuals. Three pots were used for each treatment. Soil and organic manure as FYM were mixed as follows on weight basis.

Sr. No.	Soil	Farm Yard Manure (FYM)
1	100%	0% (Control)
2	90%	10%
3	75%	25%
4	50%	50%
5	25%	75%

Pots were irrigated by 500 mL water once every day. The plants were harvested on 61st day, and the same parameters as for the experiment with different levels soil water regime were studied.

RESULTS AND DISCUSSION

Soil water and growth in *I. carnea:* Results are presented in Tables 2, 3, 4 and Fig. 1. Watering regimes had a distinct relation to the growth of plants. When plants were watered once in three days, they showed minimum shoot length, whereas maximum shoot length was recorded when plants were watered daily. In general, length of shoot increased with increased frequency of watering from once in five days to once a day (Figs. 1 and 2). Similar observations could be made for shoot diameter and dry weight of shoot also. In case of leaf area, however, biggest leaf was recorded in plants watered every third day. The general pattern of bigger leaves in more wet soils was in the experiment.

Stomatal indices and size of stomata showed significant differences with reference to watering frequencies. Stomata were smaller in plants watered at low frequency but the same could not be said of the number of stomata per unit area of leaf surface. Size of epidermal cells also could not be related with watering interval, though they were bigger in size in plants watered daily. Chlorophyll contents showed an increase with increasing dry intervals between watering (Table 4).

Soil organic matter and growth in *I. carnea:* Results are presented in Tables 5, 6, 7 and Fig. 2. This study confirmed that a qualitative relationship existed between organic matter of soil and plant growth. Shoot length, shoot diameter and dry weight were higher at higher levels of organic matter in soil. Leaves were also bigger in those plants that grew in higher organic matter levels.

The stomata were bigger in plants growing in organically rich soils while their numbers per unit leaf area were not consistent. Epidermal cells also showed a similar trend of irregularity in number per unit area.

Total chlorophyll contents showed continuous increase in the values with increasing proportion of organic manure (Table 7).

The experiment brought out that growth of *I. carnea* was directly proportional to watering frequency and organic matter of soils. Water and organic manure keep the soil wet and increase availability of plant nutrients. Similar observations were also made by Davis (1940) and Steckel (1968), who showed that rate of growth of plants increased with water content of soil. Presence of organic matter in soil helps increase water holding capacity, and hence, ensured continued high level of water supply to plants. Presence of high levels of organic matter encouraged growth of nitrophytes like *Amaranthus spinosus* (Dubesh 1947) or even nitrophilous associations (Sheriarjina 1950, Wagle 1953, Jindal 1956 and Chaphekar 1966). In the present case, however, organically rich soils have

Table 1: Length, breadth (cm) and area of leaves (cm^2) of *I. carnea* and their respective K values.

Sr. No.	Length in cm	Breadth in cm	Area in cm^2	K = (L × B)/A
1	13.0	8.5	85	1.30
2	11.0	7.5	60	1.37
3	11.0	7.5	64	1.34
4	9.0	5.5	37	1.28
5	14.5	8.5	87	1.42
6	13.5	7.5	86	1.53
7	10.5	6.5	58	1.5
8	10.2	6.0	41	1.54
9	16.5	4.5	33	1.39
10	17.5	8.0	91	1.45
11	13.5	6.5	55	1.59
12	11.0	7.0	59	1.30
13	18.0	9.0	106	1.53
14	15.5	8.5	97	1.36
15	17.5	7.5	89	1.47
16	12.0	6.5	55	1.42
17	10.0	5.5	39	1.41
18	16.5	7.0	73	1.58
19	20.0	9.5	115	1.65
20	18.0	9.0	120	1.35
				Mean "K" = 1.44

Table 2: Growth of 60 days old plants of *I. carnea* in relation to different watering frequencies (mean of 15 observations ± SEM)

Sr.No.	Watering frequency	Shoot length in cm	Shoot diameter in cm in cm	Area of 5th leaf in cm^2	Shoot dry weight in g
1	Daily	37.47 ± 5047	0.60 ±0.01	39.20± 4.25	6.65 ±0.86
2	On alternate days	29.73 ± 2.25	0.58 ±0.01	39.24 ±3.00	5.35 ± 0.69
3	Once in three days	24.46 ± 1.95	0.55 ± 0.1	39.75 ± 2.75	4.48 ± 0.46
4	Once in four days	19.53 ± 1.44	0.49 ± 0.01	28.56 ± 2.57	4.25 ± 0.47
5	Once in five days	22.4 ± 2.62	0.44 ± 0.01	30.87 ± 2.19	3.62 ± 0.39

Table 3: Number of stomata, epidermal cells, stomatal indices and size of stomata of the leaf of *I. carnea* in relation to different watering frequencies (mean of 10 observations ± SEM).

Sr. No.	Watering frequency	No. of stomata/mm^2	No. of epidermal cells	Stomatal index (SI)	Size of stomata in µ	
					Length	Breadth
1	Daily	7.33 ± 0.15	33.8 ± 0.92	16.02 ±0.44	58.79 ± 0.28	44.35 ± 0.59
2	On alternative days	7.8 ± 0.22	26.53 ± 1.08	22.99 ±0.93	54.22 ±0.04	40.74 ± 0.56
3	Once in three days	6.93 ± 0.47	25.13 ± 1.22	21.44 ± 1.39	52.73 ± 0.60	34.06 ± 0.97
4	Once in four days	6.66 ± 0.41	25.66 ± 1.18	20.55 ± 1.04	47.31 ± 0.35	41.25 ± 0.37
5	Once in five days	7.33 ± 0.27	29.46 ± 1.40	20.95 ± 0.97	45.75 ± 0.43	37.36 ± 0.90

encouraged growth of *I. carnea* probably because these organic soils were also flooded with stagnant water. It is also probable that some of the microbiological activities in flooded organic soils contribute to the prosperity of *I. carnea,* instead of other nirtophilous species reported by earlier

Table 4: Total chlorophyll in mg/g fresh weight of leaf tissue of 60 day old plant of *I. carnea* in relation to different watering frequencies (mean of 3 sample ± SEM).

Sr. No.	Watering frequency	Total chlorophyll in mg/g fresh weight	Chlorophyll *a*/*b* ratio
1	Daily	1.04 ± 0.25	1.01
2	On alternative days	1.21 ± 0.46	1.25
3	Once in three days	1.01 ± 0.21	1.43
4	Once in four days	1.48 ± 0.32	1.23
5	Once in five days	1.56 ± 0.51	1.17

Table 5: Growth of 60 days old plants of *I. carnea* grown in soils containing different levels of organic manure (FYM) (mean of 15 observations ± SEM).

Sr. No.	Percentage of organic manure in soil	Shoot length in cm	Shoot diameter in cm	Area of 5^{th} leaf in cm^2	Shoot dry weight in g
1	Control (without FYM)	31.26 ± 3.28	0.61 ± 0.01	43.82 ± 3.29	4.43 ± 0.55
2	10 %	33.6 ± 3.94	0.57 ± 0.01	39.16 ± 3.5	4.71 ± 0.70
3	25 %	39.46 ± 4.35	0.59 ± 0.02	48.28 ± 3.64	5.02 ± 0.71
4	50 %	46.06 ± 5.48	0.66 ± 0.22	65.34 ± 5.46	7.38 ±1.11
5	75 %	56.46 ± 3.68	0.73 ± 0.01	79.16 ± 3.05	7.66 ± 0.77

Table 6: Number of stomata, epidermal cells, stomatal indices and size of stomata of the leaf of *I. carnea* grown in soils containing different levels of organic manure (FYM).

Sr. no.	Percentage of organic manure in soil	No. of stomata/mm^2	No. of epidermalcells	Stomatal index (SI)	Size of stomata in μ	
					Length	Breadth
1	Control(without FYM)	7.33 ± 0.32	25.73 ± 0.75	20.90 ± 1.25	49.56 ± 0.25	38.83 ± 0.13
2	10%	6.00 ± 0.32	20.26 ± 0.70	22.63 ± 1.17	54.44 ± 1.17	42.01 ± 0.92
3	25%	6.13 ± 0.23	25.08 ± 0.75	19.56 ± 0.79	53.22 ± 1.48	41.21 ± 0.88
4	50%	8.4 ± 0.47	22.26 ± 0.97	28.16 ± 1.61	54.56 ± 1.40	42.90 ± 1.02
5	75%	7.33 ± 0.34	24.2 ± 1.12	23.74 ± 0.99	56.79 ± 0.27	44.30 ± 0.58

(Mean of 10 observation ± SEM).

Table 7: Total chlorophyll in mg/g fresh weight of leaf tissue of 60 day old plant of *I. carnea* grown in soils containing different levels of organic manure (FYM).

Sr. no.	Percentage of organic manure in soil	Total chlorophyll in mg/g fresh weight	Chlorophyll *a*/*b* ratio
1	Control (without FYM)	1.08 ± 0.15	1.39
2	10 %	1.74 ± 0.29	1.89
3	25 %	1.73 ± 0.46	1.20
4	50 %	1.83 ± 0.23	1.28
5	75 %	2.01 ± 0.02	1.20

(Mean of 3 samples ± SEM)

workers. These aspects of work, however, are beyond the scope of this research paper though solution for the question as to why this plant species alone prospers while the other nitrophytes cannot, has been attempted. Further work, hence, deal with other aspect of growth of this plant, with reference to urban habitats that are common in this city of Mumbai, i. e., grounds that are contaminated by solid waste from industries.

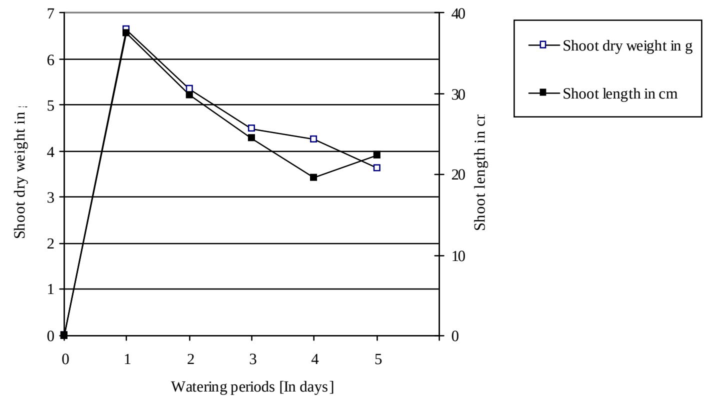

Fig. 1: Length and dry weight of shoot of 60 days old plant of *I. carnea* grown in soil in relation to different watering frequencies.

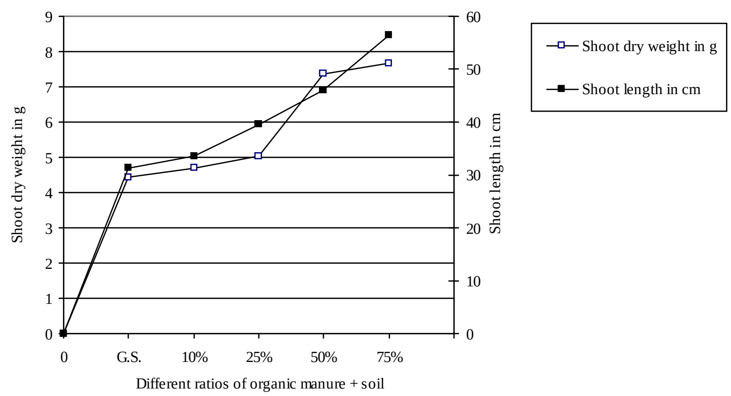

Fig. 2: Length and dry weight of shoot of 60 days old plant of *I. carnea* grown in garden soil containing different levels of organic manure (FYM).

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