CHAPTER-8

ALLELOPATHIC EFFECT OF ASSOCIATES ON *Streptocaulon sylvestre* WIGHT

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8.1. INTRODUCTION

In general, different types of plants grow at a place in an association. But in such association different species of plants are not completely harmless to other species. Even in cultivated fields, weeds of different nature grow among the crop plants. Plants growing along the boundaries of the crop fields also having some effects on cultivation. It has been observed that the residual parts of many species of plants exude some chemicals which inhibit or promote the growth of associated plants. Any direct or indirect inhibitory or stimulatory effect of one plant (including microorganism) on another through the production of chemical compounds that escape into the environment has been defined as Allelopathy by Rice (1984).

The term 'Allelopathy' was first introduced by Molisch (1937) who referred it as a biochemical interactions between all types of plants including microorganisms. With this terminology, he covered both harmful and beneficial reciprocal biochemical interactions. Tuckey (1970) stated that the most physiological and biochemical processes of plants have been reported to be adversely affected by the allelochemicals on addition to the soil or growth medium in the form of ground leaf litter, leaf leachates or extracts of plants and plant parts. Khailov (1974) mentioned that the effect of any given compound may be 'inhibitory' or 'stimulatory' which, in tern, depends on the concentration of the compounds in the surrounding medium. del Moral and Cates (1971) defined allelopathy as the inhibitor of germination, growth and metabolism of one plant due to the release of organic chemicals by another. According to Putnam and Duke (1978), allelopathy may be a habitat factor in enhancing dominance by certain weeds in a variety of agro-ecosystems.

Salisbury (1957) certainly indicated the presence of allelopathic reaction when he mentioned that anything which prevents a seed from sprouting and discourages a species from thriving, must have a powerful influence on the composition of the plant community. Meanwhile, Molisch's definition of the term has been invariably followed by most of the investigators in Asia and Europe.

According to Rice (1984), Theophrastus (Ca 300 BC) observed and described similar inhibitory effects of crop plants on other crops over 2000 years ago. Later on, no scientific research was done to varify such observations until early part of the twentieth century. Since the turn of the century allelopathic research has been mainly restricted to the cultivated crop plants only. The existence of allelopathic principle has

been well documented over the past few decades particularly in relation to its significance in both natural and agro-ecosystems (Rakhteenko *et al.*, 1973; Rice, 1976, 1979; Putnam & Duke, 1978; Rieeta 1981 and Bhowmik & Doll, 1982). In agricultural ecosystems there are many agrestals whose allelopathic influences also have been proved in the laboratory (Grümmer & Beyer, 1960; Martin & Rademacher, 1960 and Welbank, 1960; Grodzinskiy, 1965).

The ecological significance of allelopathic influence has been pointed out by Whittaker & Feeney (1971), Datta & Sinha Roy (1974), Chatterji (1975) and Lodhi (1975a). Muller (1966, 1969, 1970, 1974) demonstrated the significance of allelopathy in relation to environmental complex and threw light on the allelopathic mechanism for a dominant vegetation. In forestry the importance of allelopathic research on herbaceous or woody seed plants, fern as well as mycorrhizae and other microorganisms can be ascertained. Moreover, allelopathy has also been implicated in many field of plant sciences.

At present, considerable information are available on the role of allelopathy in cultivated and natural ecosystems. This phenomenon was studied in the last few decades in an extensive and critical way by a large number of workers in different parts of the world including Bonner & Galston (1944), Bonner(1950), Evenari (1961), Muller (1965, 1969), Rice (1967, 1972, 1976), Groner (1974, 1975), Newman & Rovira (1975), Al-Naib & Al-Mousawi (1976), Gliessman (1976, 1978), Lodhi (1976, 1978), Ballester *et al.* (1977), Newman & Miller (1977), Weaver & Klarich (1977). Fisher *et al.* (1978), Bell & Klikoff (1979), Lodhi & Killingbeck (1980), Stachon & Zimdahi (1980), Lovett & Jackson (1980), Younger *et al.* (1980), Lovett & Duffield (1981), Jobidon & Thibault (1982).

In India Datta & Sinha-Roy (1973, 1974, 1975, 1983), Sarma (1974a, 1974b), Datta & Chakraborty (1975, 1978, 1982a, 1982b), Pandya (1975, 1976, 1977), Murthy & Ravindra (1975), Murthy & Nagodra (1977), Ashraf & Sen (1978), Datta & Chatterjee (1980a, 1980b, 1980c), Datta & Bandyopadhyay (1981, 1989), Datta & Ghosh (1982, 1987, 1988), Datta & Dasmahapatra (1984, 1988), Gautam & Bishnoi (1990), Sundaramoorthy & Kalra (1991), Acharia & Sinha (1992), Agarwal & Anand (1992), Kohli & Batish (1994), Prasad (1995), Kalita & Dey (1998), Kalita (1999) and Sinha & Deo (1999) demonstrated allelopathic influences of some weedy species of plants of natural and cultivated vegetations.

Streptocaulon sylvestre Wight, a recently rediscovered critically endangered and endemic perennial herb of Eastern India (Das 1996a). Every year a 2 to 3 m tall very dense weedy vegetation develops in its natural habitat which are cleaned

manually during November-December. During manual weeding, it is experienced that the spreading branches of the weedy herb break off easily at the nodes leaving the root system intact among the residues of associated species of plants. The soluble allelochemicals which leach out or extract out from these herb or weed residues come into direct contact with the roots of *S. sylvestre*. Thus the weed infestation in this vegetation seriously interferes with the propagation and growth of the critically endangered species. Earlier, any allelopathic study on *S. sylvestre* caused by weed residues has not been undertaken by any other worker. Therefore, the present investigation was carried out to determine the presence of any allelopathic effect of the associate plants of *S. sylvestre* on the germination of its seeds and on the growth of its seedlings.

Sixteen common associate plant species were selected for the study of their probable allelopathic effects on *S. sylvestre*. Among these, eleven belongs to dicotyledons viz. *Borreria alata, Desmodium triflorum, Elephantopus scaber, Lindernia crustacea, Mitracarpus verticillatus, Phyllanthus urinaria, Phyllanthus virgatus, Prunella vulgaris, Pueraria phaseoloides, Rungia pectinata* and *Vernonia cinerea* and five belongs to monocotyledons viz. *Carex indica, Cymbopogon pendulus, Mnesithea laevis, Saccharum spontaneum* and *Sporobolus indicus.*

In the present investigation, the effect of derived concentrations (i.e. 1:2.5, 1:5, 1:10 and 1:20) of leachates both individually or in combination and extracts of areal parts or whole plant of selected species have been studied. Observations analyzed on the percentage of seed germination, percentage of inhibition or stimulation of germination, percentage of non-viability, percentile of viability, index of speed of germination, mean root length, shoot length, seedling length, percentage of inhibition or stimulation of root, shoot and seedling length, shoot vigour index, root vigour index, seedling vigour index and shoot: root ratio of seedling under different treatments. The Materials and methods used for this work has been mentioned in Chapter-2.

8.2 RESULTS AND DISCUSSION

8.2.1 EFFECT OF LEACHATES

In this investigation leachates of twelve associate species viz. *Borreria alata, Cymbopogon pendulus, Desmodium triflorum, Elephantopus scaber, Lindernia crustacea, Mitracarpus verticillatus, Mnesithea laevis, Phyllanthus virgatus, Pueraria phaseoloides, Saccharum spontaneum, Sporobolus indicus* and *Vernonia cinerea* were tested for their allelopathic effect on seed germination and seedling growth of *S. sylvestre* and the results of those experiments are presented below.

8.2.1.1 EFFECT OF LEACHATES OF *Borreria alata* ON SEED GERMINATION AND SEEDLING GROWTH OF *Streptocaulon sylvestre* WIGHT:

Table-8.1 and Plate-VII exhibit the effect of leachates of areal parts of *Borreria alata* on seed germination and seedling growth of *Streptocaulon sylvestre* Wight. The pH of the leachates solutions ranged from 8.10 to 8.52. Results reveal that leachates concentration of 1:2.5 exhibited 18.75 % inhibition on seed germination (78.00 ± 6.22 %) as against control (96.00 ± 1.63 %), whereas with the dilution of leachates at 1:5, 1:10 and 1:20 the percentage of germination was increased to 93.00 ± 1.00, 94.00 ± 2.58 and 96.00 ± 2.31, respectively. Even leachates of concentration of 1:20 showed no effect on seed germination percentage in comparison with control. Increase in concentration of the leachates (i.e. 1:20, 1:10, 1:5 and 1:2.5) led to decline of the percentile of viability (100.00, 97.92, 96.87 and 81.25, respectively).

In this investigation it was observed that the index of speed of germination was also influenced by the varied concentrations of leachate. The index of speed of germination of the seed, in comparison with control (20.13 ± 0.35), was improved by the way of stimulatory effects at the lowest concentration (1:20, 21.36 ± 0.74), but it was slow and inhibitory at the highest concentration (1:2.5, 13.04 ± 0.36). At concentrations of 1:5 and 1:10 the indices of speed of germination were 17.06 ± 0.13 and 19.74 ± 0.69 respectively.

The seedling growth of *Streptocaulon sylvestre* was affected variably in different concentrations of leachate of *Borreria alata*. Maximum shoot length was recorded at 1:10 concentration of leachate (2.82 ± 0.65 cm) and thereafter it started declining with increasing concentrations. The higher concentration of leachates i.e. 1:2.5 and 1:5 caused 64.92 and 47.76 % inhibition in shoot length as compared to control, respectively. But the diluted leachates at 1:10 and 1:20 levels showed least stimulatory effect caused 5.22 and 1.49 % stimulation in shoot length as against control. On the other hand, the leachates of *Borreria alata* showed strong inhibitory effect on root growth of *S. sylvestre* at all the concentrations and also prohibited lateral roots initiation. Although with the dilution of leachates the inhibitory effect in root length was decreased (87.10, 69.90, 51.61 and 43.01 % inhibition). Moreover, compared to the control (4.54 ± 0.89 cm), the total length of seedling of *S. sylvestre* was appreciably smaller in all concentrations of leatchates (i.e. 1.18 ± 0.47, 1.96 ± 0.62, 3.72 ± 0.86 and 3.78 ± 1.12 cm) of *B. alata*.

In this study it was seen that the shoot vigour index was more at concentration of 1:10 and 1:20 but seedling vigour index and root vigour index were less in all the

Table 8.1. Effect of leachates of areal parts of *Borreria alata* on seed germination and seedling growth of *Streptocaulon sylvestre* Wight

PARAMETERS	CONCENTRATION OF SOLUTION				
	Control	**1:2.5**	**1:5**	**1:10**	**1:20**
Solution pH	7.00	8.38	8.32	8.12	8.10
Germination percentage	96.0 ±1.63	78.0 ±6.22	93.0 ±1.00	94.0 ± 2.58	96.0 ± 2.31
Germination % inhibition or stimulation	00.00	-18.75	-3.12	-2.08	00.00
Percentile of viability	100.0	81.25	96.87	97.92	100.00
Nonviable percentage	4.00	22.00	7.00	6.00	4.00
Index of speed of germination	20.13 ± 0.35	13.04 ± 0.36	17.06 ± 0.13	19.74 ±0.69	21.36±0.74
Mean shoot length (cm) per seedling	2.68 ± 0.62	0.94 ± 0.41	1.40 ± 0.49	2.82 ± 0.65	2.72 ± 0.89
Percentage of inhibition or stimulation of shoot length	00.00	-64.92	-47.76	+5.22	+1.49
Mean root length (cm) per seedling	1.86 ± 0.30	0.24 ± 0.07	0.56 ± 0.22	0.90 ± 0.22	1.06 ± 0.28
Percentage of inhibition or stimulation of root length	00.00	-87.10	-69.90	-51.61	-43.01
Mean total length (cm) per seedling	4.54 ± 0.89	1.18 ± 0.47	1.96 ± 0.62	3.72 ± 0.86	3.78 ± 1.12
Percentage of inhibition or stimulation of seedling length	00.00	-74.00	-56.83	-18.06	-16.74
Mean number of lateral roots	0.20	00.00	00.00	00.00	00.00
Shoot vigour index	257.28	73.32	130.20	265.08	261.12
Root vigour index	178.56	18.72	52.08	84.60	101.76
Seedling vigour index	435.84	92.04	182.28	349.68	362.88
Shoot / root ratio	1.44	3.91	2.50	3.13	2.56

+ / - signs indicates stimulatory / inhibitory effect of leachates.

concentrations of leachates in comparison to the control. The shoot: root ratio followed a similar pattern of response as for shoot and root growth which were increased in all concentrations (3.91, 2.50, 3.13 and 2.56 at 1:2.5, 1:5, 1:10 and 1:20 levels, respectively) indicating more inhibition of root length than that of shoot length.

8.2.1.2 EFFECT OF LEACHATES OF *Cymbopogon pendulus* ON SEED GERMINATION AND SEEDLING GROWTH OF *Streptocaulon sylvestre* WIGHT

Results of effect of leachates of areal parts of *Cymbopogon pendulus* on seed germination and seedling development of *Streptocaulon sylvestre* Wight are shown in Table-8.2. The pH of the leachates solution ranged from 6.50 - 8.47. From the perusal of the results it is observed that the highest concentration of leachates of 1:2.5 showed more inhibitory effect on germination percentage (50.00 ± 2.58 % germination). Thereafter with the dilution of leachates (1:5 and 1:10) least inhibitory effect was found on seed germination (94.00 ± 3.46 and 96.00 ± 1.63 % germination, respectively) in comparison to control (97.00 ± 1.91 %), resulted in 3.09 and 1.03 % inhibition. Rather concentration of 1:20 showed equal effect on seed germination (i.e. 97.00 ± 1.00 % it was also observed in control (97.00 ± 1.91 %).

The index of speed of germination was inversely related to the concentration of leachates of *Cymbopogon pendulus*. The leachates of 1:2.5 resulted in slowest index of speed of germination of 5.15 ± 0.21 as against 19.31 ± 0.31 under control. But with the dilution of leachates (1:5, 1:10 and 1:20) the slowest rate of 1:25 was changed abruptely and the indices of speed of germination were promoted to 18.78 ± 1.81, 20.67 ± 1.09 and 20.99 ± 0.13 respectively.

In this investigation it was observed that leachates of *Cymbopogon pendulus* at lower concentrations stimulated the shoot and root growth of *Streptocaulon sylvestre* (Plate-VII). On the other hand, inhibition was observed in highest concentration of 1:2.5, resulted in 33.33 and 65.51 % inhibition in shoot and root length respectively, as compared to control. Besides application of leachates of 1:10 and 1:20 levels caused 3.70 and 23.70 % stimulation in shoot length over the control, respectively. Although concentration of 1:5 showed slight inhibitory effect (11.85 %) on shoot length. Similar trend of influence on growth pattern due to application of leachates of 1:5, 1:10 and 1:20 exhibited promotory effect on the root growth caused 29.88, 32.18 and 42.53 % stimulation over the control, respectively.

The total length of seedlings were appeared to be promoted at all lower concentrations. It was seen that there were 4.50, 14.86 and 31.08 % stimulation in linear growth of seedlings at 1:5, 1:10 and 1:20 levels of dilutions as against control. Only the highest concentration (1:2.5) of leachates exhibited 45.94 % decline in seedling length. Moreover, lateral roots were also initiated in almost all concentration of leachates except in 1:2.5. The seedling vigour index and root vigour index were higher at concentrations of 1:5, 1:10 and 1:20. Besides higher shoot vigour index was observed at 1:10 and 1:20 levels of leachates.

Table8.2. Effect of leachates of areal parts of *Cymbopogon pendulus* on seed germination and seedling growth of *Streptocaulon sylvestre* Wight

PARAMETERS	CONCENTRATION OF SOLUTION				
	Control	**1:2.5**	**1:5**	**1:10**	**1:20**
Solution pH	7.00	6.50	8.03	8.19	8.47
Germination percentage	97.0 ±1.91	50.0 ±2.58	94.0 ±3.46	96.0 ± 1.63	97.0 ± 1.00
Germination % inhibition or stimulation	00.00	- 48.45	-3.09	-1.03	00.00
Percentile of viability	100.0	51.55	96.91	98.97	100.00
Nonviable percentage	3.00	50.00	6.00	4.00	3.00
Index of speed of germination	19.31 ± 0.31	5.15 ± 0.21	18.78 ± 1.81	20.67 ± 1.09	20.99 ±0.13
Mean shoot length (cm) per seedling	2.70 ± 0.45	1.80 ± 0.53	2.38 ± 0.70	2.80 ± 0.67	3.34 ± 0.70
Percentage of inhibition or stimulation of shoot length	00.00	-33.33	-11.85	+3.70	+23.70
Mean root length (cm) per seedling	1.74 ± 0.22	0.60 ± 0.14	2.26 ± 0.79	2.30 ± 0.48	2.48 ± 0.66
Percentage of inhibition or stimulation of root length	00.00	-65.51	+29.88	+32.18	+42.53
Mean total length (cm) per seedling	4.44 ± 0.59	2.40 ± 0.58	4.64 ± 1.46	5.10 ± 1.13	5.82 ± 1.24
Percentage of inhibition or stimulation of seedling length	00.00	-45.94	+4.50	+14.86	+31.08
Mean number of lateral roots	0.20	00.00	0.40	1.00	1.20
Shoot vigour index	261.90	90.00	223.72	268.80	323.98
Root vigour index	168.78	30.00	212.44	220.80	240.56
Seedling vigour index	430.68	120.00	436.16	489.60	564.54
Shoot / root ratio	1.55	3.00	1.05	1.22	1.34

'+' = stimulation ; '-' = inhibition.

The shoot : root ratio of seedlings was slightly affected (1.05, 1.22 and 1.34) at all the lower concentrations of leachates (1:5, 1:10 and 1:20 respectively) in comparison to control (1.70). But in highest concentration of 1:2.5 it was increased (3.00) indicating more inhibition of root growth than shoot.

8.2.1.3 EFFECT OF LEACHATES OF *Desmodium triflorum* ON SEED GERMINATION AND SEEDLING GROWTH OF *Streptocaulon sylvestre* WIGHT

The effect of leachates of whole plant of *Desmodium triflorum* on different parameters of seed germination and seedling growth of *Streptocaulon sylvestre* Wight have been presented in Table-8.3.

Table 8.3. Effect of leachates of whole plant of *Desmodium triflorum* on seed germination and seedling growth of *Streptocaulon sylvestre* Wight

PARAMETERS	CONCENTRATION OF SOLUTION				
	Control	1:2.5	1:5	1:10	1:20
Solution pH	7.00	5.50	6.02	6.35	7.17
Germination percentage	97.0±3.00	Nil	56.0±2.83	58.0± 1.15	83.0± 2.52
Germination % inhibition or stimulation	00.00	- 100.00	-42.26	-40.20	-14.43
Percentile of viability	100.0	00.00	57.73	59.80	85.57
Nonviable percentage	3.00	100.00	44.00	42.00	17.00
Index of speed of germination	19.42 ± 0.64	00.00	6.54 ± 0.22	7.55 ± 0.11	12.73 ±0.24
Mean shoot length (cm) per seedling	2.80 ± 0.45	Nil	1.52 ± 0.55	1.54 ± 0.54	2.28 ± 0.77
Percentage of inhibition or stimulation of shoot length	00.00	-100.00	-45.71	-45.00	-18.57
Mean root length (cm) per seedling	1.94 ± 0.41	Nil	0.54 ± 0.07	0.66 ± 0.17	1.98 ± 0.72
Percentage of inhibition or stimulation of root length	00.00	-100.00	-72.16	-65.98	-2.06
Mean total length (cm) per seedling	4.74 ± 0.73	Nil	2.06 ± 0.60	2.20 ± 0.70	4.26 ± 1.45
Percentage of inhibition or stimulation of seedling length	00.00	-100.00	-56.54	-53.58	-10.12
Mean number of lateral roots	0.40	Nil	00.00	00.00	0.40
Shoot vigour index	271.60	00.00	85.12	89.32	189.24
Root vigour index	188.18	00.00	30.24	38.28	164.34
Seedling vigour index	459.78	00.00	115.36	127.60	353.58
Shoot / root ratio	1.44	00.00	2.81	2.33	1.15

+ / - signs indicates stimulatory / inhibitory effect of leachates.

The pH of the concentrated solutions ranged from 5.50 to 7.17. During this investigation it was oberved that there was deleterious effect on the seed germination of *Streptocaulon sylvestre* by the leachates of *Desmodium triflorum* in highest concentration (1:2.5) which showed strong inhibitory (100%) toxic effect and not a single seed was germinated (Plate-VII). Besides, decreasing concentration of leachates increased the germination percentage. Diluted concentrations of 1:5, 1:10 and 1:20 exhibited 56.00 ± 2.83, 58.00 ± 1.15 and 83.00 ± 2.52 % of seed germination resulting in 42.26, 40.20 and 14.43 % inhibition, respectively as against control (97.00 ± 3.00 %).

The index of speed of germination was adversely affected by the application of leachates, yet the increasing concentration of leachates decreased the index of speed of germination. The concentrations of 1:5 and 1:10 showed slowest index of speed of germination of 6.54 ± 0.22 and 7.55 ± 0.11 as against 19.42 ± 0.64 with control, respectively. While at lowest concentration (1:20) the germination rate was promoted slowly and the index of speed of germination was 12.73 ± 0.24.

In this study it was seen that trends of early seedling development followed a similar pattern of response as for germination. The shoot length exhibited inhibitory effect in a variable manner. The maximum shoot length for leachate treatments was at lowest concentration of 1:20 (2.28 ± 0.77 cm) which showed 18.57 % inhibition as against control (2.80 ± 0.45 cm). Similarly, concentrations of 1:10 and 1:5 resulted in the production of reduced shoot of 1.54 ± 0.54 and 1.52 ± 0.55 cm caused 45.00 and 45.71 % inhibition in shoot length, respectively, as compared to control.

Marked inhibition of root growth was also observed at the concentrations of 1:5 and 1:10 levels, resulting in steady decline of 72.16 and 65.98 % in root length respectively. While in lowest concentration of 1:20 slight stimulatory effect (2.06 %) was observed in root length over control.

However, average length of seedling was appeared to be inhibited at all concentrations of leachates. Lateral root initiation was occurred only at 1: 20 level of leachate. In addition, seedling vigour index, shoot vigour index and root vigour index were generally lower in all concentrations of leachates in comparison with the control. The shoot : root ratio was higher (2.81 and 2.33) at concentrations of 1:5 and 1:10 than that of control (1.44), which indicating more inhibition of root growth than shoot.

8.2.1.4 EFFECT OF LEACHATES OF *Elephantopus scaber* ON SEED GERMINATION AND SEEDLING GROWTH OF *Streptocaulon sylvestre* WIGHT:

The data on the effect of leachates of whole plant of *Elephantopus scaber* on seed germination and seedling growth of *Streptocaulon sylvestre* Wight is demonstrated in Table-8.4. The pH of the concentrated leachate solutions ranged between 8.27 to 8.35. From the perusal of data it is apparent that the highest concentration of leachate of 1:2.5 showed inhibitory effect on germination percentage (57.00 ± 3.41) as compared to control (96.00± 1.63) and thereafter it started to increasing with decreasing concentration of leachates. The dilution of leachates at 1:5 and 1:10 showed slight inhibitory effect on seed germination (94.00 ± 2.58 and 95.00 ± 2.51 %, respectively), resulting in 2.08 and 1.04 % inhibition. But, on the other hand, lowest concentration of 1:20 exhibited slight promotory effect caused 1.04 % stimulation on seed germination over the control.

In this study reciprocal relationship between the index of speed of germination and leachate concentration was also observed. The slowest index of speed of germination (9.87 ± 0.41) was recorded with the highest concentration of leachate (1:2.5) and as expected, fastest index of speed of germination (22.38 ± 0.39) was obtained in the lowest concentration (1:20) of leachates as compared with the control (20.13 ± 0.35).

In this investigation it was observed that leachate treatments of *Elephantopus scaber* markedly enhanced the shoot growth of *Streptocaulon sylvestre* (Plate-VII). Application of leachates, namely 1:5, 1:10 and 1:20 levels showed 3.73, 5.97 and 21.64 % stimulation in shoot length, respectively, over control. Only highest concentration of leachates (1:2.5) retarded the elongation of shoot length caused 22.39 % decline in comparison with control. Growth of root length, however, was also affected by different concentration of leachates. The effect was usually distinctly inhibitory at highest concentration. At lowest concentration (1:20), it was elongated more as compared to the others and became 39.78 % stimulatory over control. In addition, lateral roots were initiated in almost all concentrations of leachates except at 1:2.5.

However, longest seedling was observed in lowest concentration (i.e. 5.86 ± 0.86 cm at 1:20) and shortest in highest concentration (i.e. 2.84 ± 0.90 cm at 1:2.5), though the concentrations of 1:5 and 1:10 showed slight inhibitory effect (4.40 and 0.44 % inhibition, respectvely) in seedling length as against control (4.54 ± 0.89 cm). Moreover, shoot vigour index was more at concentrations 1:5, 1:10 and 1:20 but root vigour index and seedling vigour index were less in all concentrations of leachates except at 1:20 in comparison with control.

Table 8.4. Effect of leachates of whole plant of *Elephantopus scaber* on seed germination and seedling growth of *Streptocaulon sylvestre* Wight

PARAMETERS	CONCENTRATION OF SOLUTION				
	Control	**1:2.5**	**1:5**	**1:10**	**1:20**
Solution pH	7.00	8.35	8.32	8.29	8.27
Germination percentage	96.0 ±1.63	57.0 ± 3.41	94.0 ±2.58	95.0 ± 2.51	97.0 ± 1.91
Germination % inhibition or stimulation	00.00	- 40.60	-2.08	-1.04	+1.04
Percentile of viability	98.97	58.76	96.91	97.94	100.00
Nonviable percentage	4.00	43.00	6.00	5.00	3.00
Index of speed of germination	20.13 ± 0.35	9.87 ± 0.41	18.20 ± 0.51	20.17 ± 0.16	22.38 ±0.39
Mean shoot length (cm) per seedling	2.68 ± 0.62	2.08 ± 0.76	2.78 ± 0.68	2.84 ± 0.65	3.26 ± 0.53
Percentage of inhibition or stimulation of shoot length	00.00	-22.39	+3.73	+5.97	+21.64
Mean root length (cm) per seedling	1.86 ± 0.30	0.76 ± 0.20	1.56 ± 0.30	1.68 ± 0.44	2.60 ± 0.46
Percentage of inhibition or stimulation of root length	00.00	-59.14	-16.13	-9.68	-39.78
Mean total length (cm) per seedling	4.54 ± 0.89	2.84 ± 0.90	4.34 ± 0.93	4.52 ± 0.80	5.86 ± 0.86
Percentage of inhibition or stimulation of seedling length	00.00	-37.44	-4.40	-0.44	+29.07
Mean number of lateral roots	0.20	00.00	1.00	0.80	1.00
Shoot vigour index	257.28	118.56	261.32	269.80	316.22
Root vigour index	178.56	43.32	146.64	159.60	252.20
Seedling vigour index	435.84	161.88	407.96	429.40	568.42
Shoot / root ratio	1.44	2.73	1.78	1.69	1.25

+ / - signs indicates stimulatory / inhibitory effect of leachates.

In this study it was seen that shoot : root ratio of seedling was slightly affected at the lower concentrations of leachates, but at the highest concentration (1:2.5) it was markedly affected (2.73) causing more retardation of root growth than that of shoot.

8.2.1.5 EFFECT OF LEACHATES OF *Lindernia crustacea* ON SEED GERMINATION AND SEEDLING GROWTH OF *Streptocaulon sylvestre* WIGHT

Effect of different leachate treatments of whole plants of *Lindernia crustacea* on seed germination and seedling growth of *Streptocaulon sylvestre* Wight have been presented in Table-8.5. The pH of the leachate solutions ranged between 7.50 to 7.99. Results reveal that highest concentration (1:2.5) of leachates was observed to be more inhibitory than the further diluted grades of leachates on the percentage of seed germination. The highest concentration showed 12.00 ± 2.83 % seed germination resulted in 87.37 % inhibition, whereas further dilutions, like 1:5, 1:10 and 1:20 gradually helped to recover the percentage of germination to 48.00 ± 4.89, 87.00 ± 4.12 and 90.00 ± 1.15 leading to 49.47, 8.42 and 5.26 % decline, respectively, as against 95.00 ± 1.91 % with control.

It was observed that the lowest index of speed of germination (1.20 ± 0.33) of the seeds of *Streptocaulon sylvestre* was taken place at the highest concentration of leachate (1:2.5) of *Lindernia crustacea* and thereafter it started increasing along with the increase of dilution of leachates. Although at lowest concentration of leachates (i.e. 1:20), the index of speed of germination was 14.64 ± 0.30 which was also quite inhibitory as against control (18.87 ± 0.52).

In this investigation it was seen that the seedling growth of *Streptocaulon sylvestre* was severely inhibited by the leachate in all concentrations. The degree of inhibition of shoot and root length, as well as seedling length was proportional to the concentrations of leachate. Highest concentration of leachate was more inhibitory than the lower concentrations. While 1:2.5 concentration showed 64.62 % inhibition then the 1:20 concentration showed only 14.15 % inhibition in seedling length as compared to the control (4.24 ± 0.60 cm). Moreover, lateral root initiation was found at much diluted leachates (i.e. 1:10 and 1:20). Shoot vigour index, root vigour index and seedling vigour index were lower in all the concentrations of leachate as compared with control. At concentrations of 1:2.5, 1:5, 1:10 and 1:20 the seedling vigour indices were 18.00, 86.70, 287.10 and 327.60, respectively. For control this figure was 402.80.

However, least effect of leachates of *Lindernia crustacea* was observed on the shoot : root ratio of the seedling growth of *Streptocaulon sylvestre*. The concentrations of 1:2.5, 1:5, 1:10 and 1:20 showed the shoot : root ratio of 1.77, 1.31, 1.94 and 1.39, respectively, as against 1.46 with control. Although at 1:10 dilution, the shoot : root ratio indicated slight inhibition of root growth than that of shoot.

Table 8.5. Effect of leachates of whole plant of *Lindernia crustacea* on seed germination and seedling growth of *Streptocaulon sylvestre* Wight

PARAMETERS	CONCENTRATION OF SOLUTION				
	Control	**1:2.5**	**1:5**	**1:10**	**1:20**
Solution pH	7.00	7.50	7.99	7.96	7.92
Germination percentage	95.0 ±1.91	12.0 ± 2.83	48.0 ±4.89	87.0 ± 4.12	90.0 ± 1.15
Germination % inhibition or stimulation	00.00	- 87.37	-49.47	-8.42	-5.26
Percentile of viability	100.00	12.63	50.53	91.56	94.74
Nonviable percentage	5.00	88.00	52.00	13.00	10.00
Index of speed of germination	18.87 ± 0.52	1.20 ± 0.33	6.17 ± 0.46	13.50 ± 0.41	14.64 ±0.30
Mean shoot length (cm) per seedling	2.52 ± 0.39	0.96 ± 0.36	1.02 ± 0.54	2.18 ± 0.55	2.12 ± 0.62
Percentage of inhibition or stimulation of shoot length	00.00	-61.90	-59.52	-13.49	-15.87
Mean root length (cm) per seedling	1.72 ± 0.24	0.54 ± 0.17	0.78 ± 0.16	1.12 ± 0.29	1.52 ± 0.57
Percentage of inhibition or stimulation of root length	00.00	-68.60	-54.65	-34.88	-11.63
Mean total length (cm) per seedling	4.24 ± 0.60	1.50 ± 0.53	1.80 ± 0.65	3.30 ±0.79	3.64±1.18
Percentage of inhibition or stimulation of seedling length	00.00	-64.62	-57.54	-22.16	-14.15
Mean number of lateral roots	0.20	00.00	00.00	0.20	0.80
Shoot vigour index	239.40	11.52	48.96	189.66	190.80
Root vigour index	163.40	6.48	37.44	97.44	136.80
Seedling vigour index	402.80	18.00	86.40	287.10	327.60
Shoot / root ratio	1.46	1.77	1.31	1.94	1.39

+ / - signs indicates stimulation / inhibition.

8.2.1.6 EFFECT OF LEACHATES OF *Mitracarpus verticillatus* ON SEED GERMINATION AND SEEDLING GROWTH OF *Streptocaulon sylvestre* WIGHT

Data on seed germination and seedling growth of *Streptocaulon sylvestre* Wight in response to leachate treatments of areal parts of *Mitracarpus verticillatus* have been recorded in Table-8.6. The pH of the leachates ranged between 5.93 to 8.81.

It can be observed in Table-8.6 that highest concentration of leachate (i.e 1: 2.5) showed much inhibitory effect on the percentage of seed germination (48.00 ± 4.89) caused 48.93 % decline over control. Afterwards, with further dilutions of leachate like 1:5. 1:10 and 1:20, prohibitory effect was decreased leading to 84.00 ± 3.26 , 92.00 ± 4.32 and 92.00 ± 2.83 % seed germination, that was with 10.64, 2.13 and 2.13 % inhibition as compared to control (94.00 ± 2.58), respectively.

Table 8.6. Effect of leachates of areal parts of *Mitracarpus verticillatus* on seed germination and seedling growth of *Streptocaulon sylvestre* Wight

PARAMETERS	CONCENTRATION OF SOLUTION				
	Control	**1:2.5**	**1:5**	**1:10**	**1:20**
Solution pH	7.00	5.93	8.80	8.81	8.47
Germination percentage	94.0 ±2.58	48.0 ± 4.89	84.0 ±3.26	92.0 ± 4.32	92.0 ± 2.83
Germination % inhibition or stimulation	00.00	- 48.93	-10.64	-2.13	-2.13
Percentile of viability	100.00	51.06	89.36	97.87	97.87
Nonviable percentage	6.00	52.00	16.00	8.00	8.00
Index of speed of germination	18.88 ± 0.51	7.63 ± 0.48	15.52 ± 0.30	17.94 ± 0.60	17.18 ±0.31
Mean shoot length (cm) per seedling	2.66 ± 0.37	2.02 ± 0.61	3.30 ± 0.72	3.40 ± 0.43	2.94 ± 0.36
Percentage of inhibition or stimulation of shoot length	00.00	-24.06	+24.06	+27.82	+10.53
Mean root length (cm) per seedling	2.14 ± 0.22	0.52 ± 0.10	1.92 ± 0.56	2.96 ± 0.47	1.86 ± 0.25
Percentage of inhibition or stimulation of root length	00.00	-75.70	-10.28	+38.32	-13.08
Mean total length (cm) per seedling	4.80 ± 0.39	2.54 ± 0.71	5.22 ± 1.20	6.36 ± 0.70	4.80 ± 0.48
Percentage of inhibition or stimulation of seedling length	00.00	-47.08	+8.75	+32.50	00.00
Mean number of lateral roots	0.40	00.00	1.00	1.00	1.00
Shoot vigour index	250.04	96.96	277.20	312.80	270.48
Root vigour index	201.16	24.96	161.28	272.32	171.12
Seedling vigour index	451.20	121.92	438.48	585.12	441.60
Shoot / root ratio	1.24	3.88	1.72	1.15	1.58

+ = Stimulation , - = Inhibition

The highest concentration of leachate (1:2.5) showed slow index of speed of germination of 7.63 ± 0.48 as against 18.88 ± 0.51 in control. Whereas rest of the diluted concentrations of leachate like 1:5. 1:10 and 1:20 exhibited the index of speed of germination of 15.52 ± 0.30, 17.94 ± 0.60 and 17.18 ± 0.31, respectively, that was with slight delayed in comparison to control.

In the present investigation it was observed that the seedling growth of *Streptocaulon sylvestre* was markedly enhanced in almost all the diluted concentrations of leachate of *Mitracarpus verticillatus*. Only the least dilution of leachate (1: 2.5) prohibited the elongation of seedling length (47.08 %) (Plate-VIII). Treatments of leachates, namely 1:5, 1:10 and 1:20 dilutions, exhibited 24.06, 27.82 and 10.53 % enhancement in shoot length over control respectively. An increase of 38.32 % was observed in root length with 1:10 dilution of leachate, while the dilutions of 1:2.5, 1:5 and 1:20 levels caused 75.70, 10.28, and 13.08 % decline in root length, respectively, as against control. However it was quite interesting to note the 8.75 and 32.50 % stimulation in seedling length at 1:5 and 1:10 levels of concentrations, respectively. But the treatment with 1:20 level showed equal (4.80 ± 0.48 cm) length of seedling to that of the control (4.80 ± 0.39 cm). Meanwhile lateral roots were also initiated in almost all dilutions of leachate except at 1:2.5.

In this study it was seen that seedling vigour index and root vigour index were more at 1:10 dilution, while in all other concentrations they were less than that of control. Although shoot vigour index was higher at all the lower concentration of leachates (i.e. 1:5, 1:10and 1:20). At the highest concentration (1:2.5) the shoot : root ratio of seedling was highly increased (3.88) over the control (1.24) due to comparatively more inhibition of root growth.

8.2.1.7 EFFECT OF LEACHATES OF *Mnesithea laevis* ON SEED GERMINATION AND SEEDLING GROWTH OF *Streptocaulon sylvestre* WIGHT.

Table - 8.7 exhibits the effect of leachates of areal parts of *Mnesithea laevis* on selected parameters of seed germination and seedling development of *Streptocaulon sylvestre* Wight. The pH of the leachates ranged between 6.00 - 7.97.

Results of experiments showed that the highest concentration of leachates (1:2.5) was observed to be more inhibitory than rest of the treated dilutions. Application of highest concentration of leachates (1:2.5) obtained only 12.00 ± 1.63 % germination caused 87.62 % injurious inhibitory effect. Besides, concentration of 1:5, 1:10 and 1:20 hastily increased the germination percentage to 81.00 ± 5.00,

91.00 ± 3.78 and 91.00 ± 1.91 resulted in only 16.49, 6.18 and 6.18 % inhibition in seed germination, respectively, as against control (97.00 ± 3.00 %). Similar trend of injurious effect on the index of speed of germination with highest concentration of leachates (1: 2.5) was also recorded. Although lower concentrations of leachates of 1:5, 1:10 and 1:20 showed comparatively high index of

Table 8.7. Effect of leachates of areal parts of *Mnesithea laevis* on seed germination and seedling growth of *Streptocaulon sylvestre* Wight

PARAMETERS	CONCENTRATION OF SOLUTION				
	Control	**1:2.5**	**1:5**	**1:10**	**1:20**
Solution pH	7.00	6.00	7.20	7.85	7.97
Germination percentage	97.00±3.00	12.00 ± 1.63	81.00 ± 5.00	91.00 ± 3.78	91.00 ± 1.91
Germination % inhibition or stimulation	00.00	-87.62	-16.49	-6.18	-6.18
Percentile of viability	100.00	12.37	83.50	93.81	93.81
Nonviable percentage	3.00	88.00	19.00	9.00	9.00
Index of speed of germination	19.42 ± 0.64	1.16 ± 0.13	11.30 ± 0.46	15.20 ± 0.57	14.95 ±0.22
Mean shoot length (cm) per seedling	2.80 ± 0.45	0.26 ± 0.10	2.56 ± 0.59	2.76 ± 0.63	2.78 ± 0.61
Percentage of inhibition or stimulation of shoot length	00.00	-90.50	-24.00	-1.43	-0.71
Mean root length (cm) per seedling	1.94 ± 0.41	0.26 ± 0.10	2.46 ± 0.74	2.36 ± 0.80	2.34 ± 0.60
Percentage of inhibition or stimulation of root length	00.00	-59.78	+26.80	+21.65	+20.62
Mean total length (cm) per seedling	4.74 ± 0.73	0.52 ± 0.22	5.02 ± 1.26	5.12 ± 1.29	5.12 ± 1.17
Percentage of inhibition or stimulation of seedling length	00.00	-89.02	+5.90	+8.01	+8.01
Mean number of lateral roots	0.40	00.00	0.60	0.60	1.20
Shoot vigour index	271.60	3.19	207.36	251.16	252.98
Root vigour index	188.18	3.19	199.26	214.76	212.94
Seedling vigour index	459.78	6.24	406.62	465.92	465.92
Shoot / root ratio	1.44	1.00	1.04	1.17	1.19

+ / - signs indicates stimulatory / inhibitory effect of leachates.

speed of germination of 11.30 ± 0.46, 15.20 ± 0.57 and 14.95 ± 0.22 respectively. For control this figure was 19.42 ± 0.64.

It was observed that the seedling growth of *Streptocaulon sylvestre* was severely inhibited by the leachates of *Mnesithea laevis* in highest concentration (1:2.5). But in diluted concentrations (1:5, 1:10 and 1:20) leachates became provocative and markedly enhanced the seedling growth. The shoot growth rate did not follow the same trend as that of the root. Application of leachates of 1:5,1:10 and 1:20 showed 24.00, 1.43 and 0.71 % inhibition in shoot length, respectively, as compared with control, while the corresponding concentrations caused 26.80, 21.65 and 20.62 % stimulation in root length over control, respectively. Moreover, lateral roots were also developed under these concentrations.

However, it can be seen that there were 5.90, 8.01 and 8.01 % increase in the length of seedlings at 1:5,1:10and 1:20 levels of concentrations, respectively, in comparison with the control. Root vigour index was higher at concentrations of 1:5,1:10 and 1:20, while the shoot vigour index was lower with all the applied concentrations of leachates. The shoot : root ratio of seedlings at all treatments were generally lower (1.00, 1.04 , 1.17 and 1.19) than that of control (1.44) which indicated more root growth of seedling in all concentration of leachates.

8.2.1.8 EFFECT OF LEACHATE OF *Phyllanthus virgatus* ON SEED GERMINATION AND SEEDLING GROWTH OF *Streptocaulon sylvestre* WIGHT.

Effect of different concentrations of leachates of whole plant of *Phyllanthus virgatus* on seed germination and seedling growth of *Streptocaulon sylvestre* Wight are presented in Table -8.8. The pH of the leachates ranged from 6.69 to 7. 35. Results indicate that almost equal trend of response was observed on germination percentage due to application of all the three higher concentrations of leachates. In this case germination percentage were 70.00 ± 5.03, 70.00 ± 6.21 and 76.00 ± 4.32 at 1:2.5, 1:5 and 1:10 dilutions of leachates, respectively. However, these concentrations were observed to be inhibitory (27.10, 27.10 and 20.83 %) on seed germination when compared to control. On the other hand, only lowest concentration of leachate of 1:20 exhibited maxmimum percentage of germination (94.00 ± 2.00) which showed only 2.08 % inhibition.

Observation of the effect of leachates on the index of speed of germination also exhibited similar pattern of response as in the case of germination percentage. While the index of speed of germination was 15.06 ± 0.41 with lowest concentration of leachates (1:20) then the three higher concentrations of leachates (1:2.5, 1:5 and 1:10) showed

comparatively slow index of speed of germination of 11.35 ± 0.53, 10.51 ± 0.99 and 12.13 ± 0.59, respectively. However, inhibition of index of speed of germination was observed in all treatments with leachates.

In the present investigation it was observed that leachates of *Phyllanthus virgatus* decreased the seedling growth of *Streptocaulon sylvestre* . The length of shoot , root and

Table 8.8. Effect of leachates of whole plant of *Phyllanthus virgatus* on seed germination and seedling growth of *Streptocaulon sylvestre* Wight

PARAMETERS	CONCENTRATION OF SOLUTION				
	Control	**1:2.5**	**1:5**	**1:10**	**1:20**
Solution pH	7.00	6.69	6.78	7.13	7.35
Germination percentage	96.0 ±1.63	70.0 ± 5.03	70.0 ±6.21	76.0 ± 4.32	94.0 ± 2.00
Germination % inhibition or stimulation	00.00	-27.08	-27.08	-20.83	-2.08
Percentile of viability	100.00	72.92	72.92	79.17	97.92
Nonviable percentage	4.00	30.00	30.00	24.00	6.00
Index of speed of germination	18.96 ± 0.32	11.35 ± 0.53	10.51 ± 0.99	12.13 ±0.59	15.06 ±0.41
Mean shoot length (cm) per seedling	2.58 ± 0.44	1.30 ± 0.49	1.32 ± 0.59	2.02 ± 0.69	2.04 ± 0.40
Percentage of inhibition or stimulation of shoot length	00.00	-49.61	-48.84	-21.70	-20.93
Mean root length (cm) per seedling	1.74 ± 0.14	1.22 ± 0.35	1.26 ± 0.53	1.50 ± 0.57	1.84 ± 0.46
Percentage of inhibition or stimulation of root length	00.00	-29.88	-27.58	-13.79	+5.75
Mean total length (cm) per seedling	4.32 ± 0.42	2.52 ± 0.82	2.58 ± 1.12	3.52 ± 1.25	3.88 ± 0.83
Percentage of inhibition or stimulation of seedling length	00.00	-41.66	-40.28	-18.52	-10.18
Mean number of lateral roots	0.40	0.20	00.00	00.00	1.00
Shoot vigour index	247.68	91.00	92.40	153.52	191.76
Root vigour index	167.04	85.40	88.20	114.00	172.96
Seedling vigour index	414.72	176.40	180.60	267.52	364.72
Shoot / root ratio	1.48	1.06	1.05	1.34	1.10

+ / - signs indicates stimulatory / inhibitory effects of leachates.

seedling were reduced under the influence of different concentrations of leachates. Only the lowest concentration (1:20) showed slight promotory effect in root elongation (+ 5.75 %). At the growth stage, the higher concentration proved to be more restraining. The maximum seedling length achieved under the treatment with 1:20 level of dilution (3.88 ± 0.83 cm) whereas treatment with 1:2.5 level resulted in the production of shortest seedlings (2.52 ± 0.82 cm) . For control this figure was 4.32 ± 0.42 cm. Moreover lateral root was also initiated in some concentrations.

During the study it was observed that seedling vigour index, shoot vigour index and root vigour index were generally lower in all concentrations of leachates. Highest seedling vigour index (364.72) was observed in 1:20 level and lowest (176.40) in 1:2.5 level of leachates as against 414.72 with control. The shoot : root ratio of all the concentrations were generally lower (1.06, 1.05, 1.34 and 1.10) than that of control (1.48) which indicated comparatively better growth of root system than shoot.

8.2.1.9 EFFECT OF LEACHATES OF *Pueraria phaseoloides* ON SEED GERMINATION AND SEEDLING GROWTH OF *Streptocaulon syslvestre* WIGHT.

Results of treatments with the leachates of area parts of *Pueraria phaseoloides* on different parameters of germination and seedling growth of *Streptocaulon sylvestre* Wight are given in Table - 8.9. The pH of the leachate solutions ranged between 4.50 - 4.75.

From the perusal of the results, it is apparent that there was deleterious effect on the percentage of germination in all dilutions of leachates which exhibited firm and inhibitory toxic effect (91.75 - 100.00 % inhibition). No germination was occurred at 1:2.5 and 1:5 levels of leachates. Although at lower concentrations of 1:10 and 1:20 germination occurred but percentage was very low (5.00 ± 1.00 and 8.00 ± 2.31 %, respectively). A similar trend of response was also observed in the case of index of speed of gremination. However, the effect of leachates of *Pueraria phaseoloides* on seed germination of *Streptocaulon sylvestre* was drastic and inhibitory.

In this investigation it was seen that there was detrimental effect on the growth of seedling of *Streptocaulon sylvestre* with the leachates of *Pueraria phaseoloides* in all concentrations. At lower concentrations (1:10 and 1:20), although germination occurred but seedling growth was highly hindered caused 90.99 and 89.19 % inhibition in seedling length, respectively, as compared with control. Shoot vigour index, root vigour index and seedling vigour index were also very low (almost negligible) in viable concentrations. Besides, the shoot : root ratio of seedling was lower (1.00 and 1.40) than that of control (1.71), indicating more inhibition of shoot growth than root.

Table 8.9. Effect of leachates of areal parts of *Pueraria phaseoloides* on seed germination and seedling growth of *Streptocaulon sylvestre* Wight

PARAMETERS	CONCENTRATION OF SOLUTION				
	Control	1:2.5	1:5	1:10	1:20
Solution pH	7.00	4.50	4.60	4.68	4.75
Germination percentage	97.00±1.91	Nil	Nil	5.00 ± 1.00	8.00 ± 2.31
Germination % inhibition or stimulation	00.00	-100.00	-100.00	-94.84	-91.75
Percentile of viability	100.00	00.00	00.00	5.15	8.25
Nonviable percentage	3.00	100.00	100.00	95.00	92.00
Index of speed of germination	19.31 ± 0.31	00.00	00.00	0.41 ± 0.09	0.68 ±0.14
Mean shoot length (cm) per seedling	2.70 ± 0.45	Nil	Nil	0.20 ± 0.03	0.28 ± 0.04
Percentage of inhibition or stimulation of shoot length	00.00	-100.00	-100.00	-92.59	-89.63
Mean root length (cm) per seedling	1.74 ± 0.22	Nil	Nil	0.20 ± 0.03	0.20 ± 0.03
Percentage of inhibition or stimulation of root length	00.00	-100.00	-100.00	-88.50	-88.50
Mean total length (cm) per seedling	4.44 ± 0.59	Nil.	Nil	0.40 ± 0.06	0.48 ± 0.07
Percentage of inhibition or stimulation of seedling length	00.00	-100.00	-100.00	-90.99	-89.19
Mean number of lateral roots	0.20	00.00	00.00	00.00	00.00
Shoot vigour index	261.90	00.00	00.00	1.00	2.24
Root vigour index	168.78	00.00	00.00	1.00	1.60
Seedling vigour index	430.68	00.00	00.00	2.00	3.84
Shoot / root ratio	1.55	00.00	00.00	1.00	1.40

Signs + / - indicates effect of leachates. '+' for stimulatory and '-' for inhibitory.

8.2.1.10 EFFECT OF LEACHATES OF *Saccharum spontaneum* ON SEED GERMINATION AND SEEDLING GROWTH OF *Streptocaulon sylvestre* WIGHT.

The data of the effect of leachates of the areal parts of *Saccharum spontaneum* on seed germination and seedling growth of *Streptocaulon sylvestre* are exhibited in Table -8.10. The pH of the leachate solutions ranged between 5.66 - 8.65.

From the perusal of the data it is observed that there was injurious effect on percentage of germination of *Streptocaulon sylvestre* in the highest concentration of leachates (1:2.5) of *Saccharum spontaneum*. The highest concentration achieved negligible i.e. 5.00 ± 1.0 % seed germination leading to as high as 94.84 % toxic

Table 8.10. Effect of leachates of areal parts of *Saccharum spontaneum* on seed germination and seedling growth of *Streptocaulon sylvestre* Wight

PARAMETERS	CONCENTRATION OF SOLUTION				
	Control	1:2.5	1:5	1:10	1:20
Solution pH	7.00	5.66	7.25	8.65	8.60
Germination percentage	97.00 ±3.00	5.00 ± 1.00	81.00 ± 4.43	82.00 ± 2.58	91.00 ± 1.00
Germination % inhibition or stimulation	00.00	-94.84	-16.49	-15.46	-6.18
Percentile of viability	100.00	5.15	83.50	84.54	93.81
Nonviable percentage	3.00	95.00	19.00	18.00	9.00
Index of speed of germination	19.42 ± 0.64	0.70 ± 0.22	8.95 ± 0.35	11.67 ± 0.23	15.90 ±0.21
Mean shoot length (cm) per seedling	2.80 ± 0.45	0.24 ± 0.07	1.88 ± 0.62	1.90 ± 0.48	2.82 ± 0.51
Percentage of inhibition or stimulation of shoot length	00.00	-91.43	-32.86	-32.14	+0.71
Mean root length (cm) per seedling	1.94 ± 0.41	0.20 ± 0.03	0.56 ± 0.10	0.86 ± 0.21	2.00 ± 0.27
Percentage of inhibition or stimulation of root length	00.00	-89.69	-71.13	-55.67	+3.09
Mean total length (cm) per seedling	4.74 ± 0.73	0.44 ± 0.10	2.44 ± 0.71	2.76 ± 0.45	4.82 ± 0.63
Percentage of inhibition or stimulation of seedling length	00.00	-90.71	-48.52	-41.77	+1.68
Mean number of lateral roots	0.40	00.00	00.00	00.60	00.20
Shoot vigour index	271.60	1.20	152.28	155.80	256.62
Root vigour index	188.18	1.00	45.36	70.52	182.00
Seedling vigour index	459.78	2.20	197.64	226.32	438.62
Shoot / root ratio	1.44	1.20	3.36	2.21	1.41

+ / - signs indicates stimulatory / inhibitory effects of leachates.

inhibition. Afterwards with the further dilution of leachates (1:5, 1:10 and 1:20), the percentage of germination was increased abruptly to 81.00 ± 4.43, 82.00 ± 2.58 and 91.00 ± 1.00 which showed the reduction of inhibition to only 16.49, 15.46 and 6.18 %, respectively, as compared to control (97.00 ± 3.00 %). Similarly slowest (negligible) index of speed of germination (0.70 ± 0.22) was observed at the lowest dilution of leachates (1:2.5) and thereafter it was increased with the increase of dilution of leachates. Although at lowest concentration of leachates (1:20) maximum index of speed of germination was recorded (15.90 ± 0.21) but it showed clear inhibition as against control (19.42 ± 0.64).

The growth of seedlings was also noticed to be inhibited under different concentration of leachates (Plate-VII). The seedling length was progressively decreased by increasing concentration of leachates and the decrease reached a maximum (0.44 ± 1.0 cm) in 1:2.5 level of concentration. Leachate treatments retarded the growth of both shoot and root at 1:2.5, 1:5 and 1:10 levels, whereas shoot and root growth were slightly increased at 1:20 level of dilution. Moreover, lateral roots were also initiated under lower concentration of leachates. Inspite of that seedling vigour index, shoot vigour index and root vigour index were lower in all the dilution of leachates as compared to control.

In the present investigation it was observed that the shoot : root ratio of seedling was higher (3.36 and 2.21) at the concentrations of 1:5 and 1:10 over the control (1.44), which indicated more inhibition of growth of root system of seedling. Besides, under the concentration of 1:2.5 and 1:20 the shoot : root ratio were 1.20 and 1.41 respectively.

8.2.1.11 EFFECT OF LEACHATES OF *Sporobolus indicus* ON SEED GERMINATION AND SEEDLING GROWTH OF *Streptocaulon sylvestre* WIGHT.

Effect of different concentration of leachates of whole plant of *Sporobolus indicus* on seed germination and seedling growth of *Streptocaulon sylvestre* Wight are shown in Table-8.11 and Plate-VII. The pH of different leachate solutions ranged between 4.89 - 8.20. From the perusal of the data it is evident that highest concentration of leachates of 1:2.5 exhibited more inhibitory effect (69.47 % inhibition) on germination percentage (29.00 ± 6.40) as against 95.00 ± 2.51 % with control. Subsequently, diluted leachates of 1:5,1:10 and 1:20 improved the germination percentage to 84.00 ± 3.65, 86.00 ± 2.58 and 94.00 ± 1.15 respectively. However

Table 8.11. Effect of leachates of whole plant of *Sporobolus indicus* on seed germination and seedling growth of *Streptocaulon sylvestre* Wight

PARAMETERS	CONCENTRATION OF SOLUTION				
	Control	**1:2.5**	**1:5**	**1:10**	**1:20**
Solution pH	7.00	4.89	7.45	8.20	8.18
Germination percentage	95.0 ± 2.51	29.0 ± 6.40	84.0 ±3.65	86.0 ± 2.58	94.0 ± 1.15
Germination % inhibition or stimulation	00.00	-69.47	-11.57	-9.47	-1.05
Percentile of viability	100.00	30.53	88.42	90.53	98.94
Nonviable percentage	5.00	71.00	16.00	14.00	6.00
Index of speed of germination	19.00 ± 0.69	3.58 ± 0.58	17.16 ±0.43	16.60 ± 0.28	19.71 ±0.54
Mean shoot length (cm) per seedling	2.70 ± 0.58	1.26 ± 0.47	3.00 ± 0.57	3.20 ± 0.36	3.50 ± 0.37
Percentage of inhibition or stimulation of shoot length	00.00	-53.33	+11.11	+18.52	+29.63
Mean root length (cm) per seedling	1.56 ± 0.30	1.02 ± 0.43	2.76 ± 0.49	2.66 ± 0.29	2.52 ± 0.32
Percentage of inhibition or stimulation of root length	00.00	-34.61	+76.92	+70.51	+61.54
Mean total length (cm) per seedling	4.26 ± 0.88	2.28 ± 0.89	5.76 ± 1.02	5.86 ± 0.40	6.02 ± 0.68
Percentage of inhibition or stimulation of seedling length	00.00	-46.47	+35.21	+37.56	+41.31
Mean number of lateral roots	0.20	00.00	0.20	1.40	1.60
Shoot vigour index	256.50	36.54	252.00	275.20	329.00
Root vigour index	148.20	29.58	231.84	228.76	236.88
Seedling vigour index	404.70	66.12	483.84	503.96	565.88
Shoot / root ratio	1.73	1.23	1.10	1.20	1.39

+ / - signs indicates stimulatory / inhibitory effects of leachates.

increased in concentration of the leachates (1:20, 1:10, 1:5 and 1:2.5) led to decreased of the percentile of viability of seeds to 98.95, 90.53, 88.42 and 30.53 % caused 1.05, 9.47, 11.57 and 69.47 % inhibition in seed germination, respectively, over the control.

The index of speed of germination was inversely related to the concentration

EXPLANATIONS OF PHOTOGRAPHS

Plate VII.

Allelopathic effects of commonly associated plants of *Streptocaulon sylvestre* Wight [Dilutions: A= Control; B= 1: 2.5; C= 1: 5; D= 1: 10; E = 1: 20]

Photo 1. Effects with the leachates of *Elephantopus scaber* in different concentrations.

Photo 2. Effects with the leachates of *Sporobolus indicus* in different concentrations.

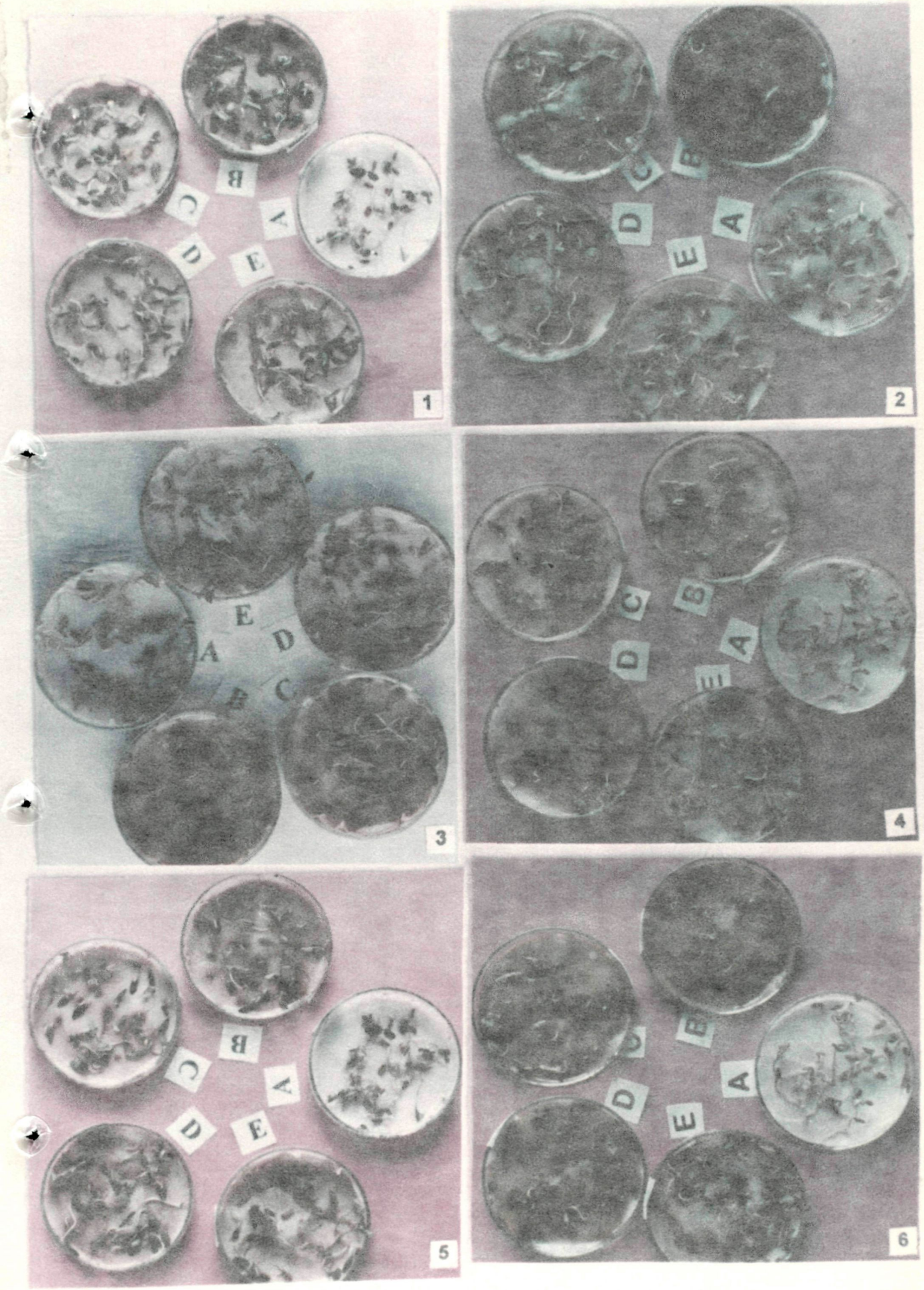
Photo 3. Effects with the leachates of *Cymbopogon pendulus* in different concentrations.

Photo 4. Effects with the leachates of *Saccharum spontaneum* in different concentrations.

Photo 5. Effects with the leachates of *Borreria alata* in different concentrations.

Photo 6. Effects with the leachates of *Desmodium triflorum* in different concentrations.

PLATE VII



of leachates. The highest concentration of leachates of 1:2.5 showed slowest index of speed of germination of 3.58 ± 0.58 and afterwards with the decreasing concentration (1:5, 1:10 and 1:20) it was increased and became 17.16 ± 0.43, 16.60 ± 0.28 and 19.71± 0.54, respectively. While the index of speed of germination was 19.00 ± 0.69 under control.

The growth of seedlings was appeared to be promoted at almost all the concentration of leachates, only except the highest concentration (1:2.5) where it was retarded (46.47 %). Application of leachates of 1:5, 1:10, and 1:20 dilutions showed 11.11, 18.52 and 29.63 % increase in shoot length, respectively, over control. Similarly, the corresponding concentrations of leachates also exhibited 76.92, 70.51 and 61.54 % enhancement in root length. Moreover, lateral roots were developed in almost all concentrations of leachates except at 2:2.5.

In the present investigation it was observed that the seedling vigour index, root vigour index and shoot vigour index were more in all lower concentrations of 1:5, 1:10, 1:20, but they were less at highest concentration of 1:2.5. The shoot : root ratio of seedling at all concentrations of leachates were lower (i.e. 1.23, 1.10, 1.20 and 1.39) than that of control (1.73) which indicated better growth of root system.

8.2.1.12 EFFECT OF LEACHATES OF *Vernonia cinerea* ON SEED GERMINATION AND SEEDLING GROWTH OF *Streptocaulon sylvestre* WIGHT.

Results of the effect of leachates of whole plant of *Vernonia cinerea* on different parameters of seed germination and seedling growth of *Streptocaulon sylvestre* Wight are presented in Table - 8.12. The pH of different leachate solutions ranged between 7.00 - 8.23. During this investigation it was observed that treatment with highest concentration of leachates (1;2.5) achieved 59.00 ± 2.51 % of seed germination resulted in 38.54 % inhibition as compared to control (96.00 ± 1.63 %). Thereafter, germination percentage increased linearly with decreasing concentration of leachates reaching a maximum of 95.00 % with the dilutions of 1:10 and 1:20 levels. Inspite of that, application of 1:5, 1:10 and 1:20 levels caused 21.87, 1.04 and 1.04 % inhibition in seed germination, respectively, as against control.

The index of speed of germination of seed was variably delayed with increasing concentration of leachates of *Vernonia cinerea*. The leachate levels, namely 1:2.5 and 1:5 showed slow index of speed of germination of 11.31 ± 0.36 and 14.60 ± 0.49 respectively. Besides diluted leachates, namely 1:10 and 1:20 showed a much higher index of speed of germination of 20.45 ± 1.27 and 19.47 ± 1.12, respectively, in comparison to the control (18.96 ± 0.32).

Table 8.12. Effect of leachates of whole plant of *Vernonia cinerea* on seed germination and seedling growth of *Streptocaulon sylvestre* Wight

PARAMETERS	CONCENTRATION OF SOLUTION				
	Control	1:2.5	1:5	1:10	1:20
Solution pH	7.00	7.00	7.50	8.20	8.23
Germination percentage	96.0 ±1.63	59.0 ± 2.51	75.0 ±3.41	95.0 ± 3.78	95.0 ± 2.51
Germination % inhibition or stimulation	00.00	-38.54	-21.87	-1.04	-1.04
Percentile of viability	100.00	61.46	78.12	98.96	98.96
Nonviable percentage	4.00	41.00	25.00	5.00	5.00
Index of speed of germination	18.96 ± 0.32	11.31 ± 0.36	14.60 ± 0.49	20.45 ±1.27	19.47 ±1.12
Mean shoot length (cm) per seedling	2.58 ± 0.44	1.46 ± 0.54	2.86 ± 0.52	3.00 ± 0.67	3.38 ± 0.35
Percentage of inhibition or stimulation of shoot length	00.00	-43.41	+10.85	+16.28	+31.01
Mean root length (cm) per seedling	1.74 ± 0.14	0.68 ± 0.18	1.32 ± 0.31	1.44 ± 0.45	2.28 ± 0.36
Percentage of inhibition or stimulation of root length	00.00	-60.92	-24.14	-17.24	+31.03
Mean total length (cm) per seedling	4.32 ± 0.42	2.14 ± 0.72	4.18 ± 0.77	4.44 ± 0.99	5.66 ± 0.66
Percentage of inhibition or stimulation of seedling length	00.00	-50.46	-3.24	+2.77	+31.02
Mean number of lateral roots	0.40	00.00	0.00	0.60	1.60
Shoot vigour index	247.68	86.14	214.50	285.00	321.10
Root vigour index	167.04	40.12	99.00	136.80	216.60
Seedling vigour index	414.72	126.26	313.50	421.80	537.70
Shoot / root ratio	1.48	2.15	2.16	2.10	1.48

+ / - signs indicates stimulatory / inhibitory effects of leachates.

Seedling growth was also varied greatly under the influence of different concentrations of leachates (Plate-VIII). Treatments with the dilutions of 1:5, 1:10 and 1:20 levels manifested 10.85, 16.28 and 31.01 % more elongation of shoot length, respectively, over the control. Though the highest concentration of leachates (1:2.5)

exhibited 43.41 % inhibition in shoot elongation. Moreover, it was observed that the tendency of root growth did not follow the similar trend as the shoot. It was usually inhibited at higher concentrations, but only at the lowest concentration (1:20) root elongation was stimulated (31.03 %). Inspite of that lateral roots were also developed at lower concentrations.

In this investigation it was seen that the seedling vigour index and shoot vigour index were lower at concentrations of 1:2.5 and 1:5 but they were higher with 1:10 and 1:20 dilutions. Although the root vigour index was higher at lowest concentration (1:20), but it was definitely lower with all other higher concentrations as against control. With 1:2.5, 1:5 and 1;10 dilutions the shoot : root ratio of seedling was higher (2.15, 2.16 and 2.10, respectively) than that of control (1.48) indicating more inhibition of root growth as compared to that of shoot.

8.2.2. EFFECT OF EXTRACTS

The present study demonstrates the influence of extracts of seven common associate species of *Streptocaulon sylvestre* viz. *Borreria alata, Carex indica, Cymbopogon pendulus, Phyllanthus urinaria, Prunella vulgaris, Pueraria phaseoloides* and *Rungia pectinata* on seed germination and seedling growth of *Streptocaulon sylvestre,* the results of which are discussed below.

8.2.2.1. EFFECT OF EXTRACTS OF *Borreria alata* ON SEED GERMINATION AND SEEDLING GROWTH OF *Streptocaulon sylvestre* WIGHT.

Different parameters of seed germination and seedling growth of *Streptocaulon sylvestre* Wight under the influence of extracts of areal parts of *Borreria alata* have been presented in Table-8.13. The pH of the different dilutions of extracts ranged from 8.20 to 8.80. In the present investigation it was found that the increase in concentration of the extracts led to decrease in the percentage of germination. The application of 1:10, 1:5 and 1:2.5 dilutions of extracts caused 1.04, 15.62 and 32.29 % inhibition in seed germination, respectively, over the control, expressing clear decline of the percentile of viability. Moreover, lowest concentration of extracts (1:20) appeared to have no recognisable effect in seed germination as it produced no different result from that of the control (i.e. 96.00 %).

The index of speed of germination was increased linearly with decreasing concentration of extracts, and it became almost equal to the control (i.e. 20.13 ± 0.35) at the 1:20 dilution of the extracts (20.52 ± 0.30). The slowest index of speed of germination (8.95 ± 0.35) was recorded at the highest concentration of extracts (1:2.5).

Table 8.13. Different parameters of seed germination and seedling growth of *Streptocaulon sylvestre* Wight under the influence of extracts of areal parts of *Borreria alata.*

PARAMETERS	CONCENTRATION OF SOLUTION				
	Control	**1:2.5**	**1:5**	**1:10**	**1:20**
Solution pH	7.00	8.80	8.55	8.23	8.20
Germination percentage	96.0 ±1.63	65.0 ± 3.78	81.0 ±4.43	95.0 ± 1.00	96.0 ± 2.83
Germination % inhibition or stimulation	00.00	-32.29	-15.62	-1.04	00.00
Percentile of viability	100.00	67.71	84.37	98.96	100.00
Nonviable percentage	4.00	35.00	19.00	5.00	4.00
Index of speed of germination	20.13 ± 0.35	8.95 ± 0.35	11.42 ± 0.20	18.99 ± 0.22	20.52 ±0.30
Mean shoot length (cm) per seedling	2.68 ± 0.62	0.78 ± 0.13	1.06 ± 0.26	2.40 ± 0.60	2.44 ± 0.74
Percentage of inhibition or stimulation of shoot length	00.00	-70.89	-60.44	-10.45	-8.95
Mean root length (cm) per seedling	1.86 ± 0.30	0.22 ± 0.07	0.44 ± 0.08	0.86 ± 0.17	1.28 ± 0.24
Percentage of inhibition or stimulation of root length	00.00	-88.17	-76.34	-53.76	-31.18
Mean total length (cm) per seedling	4.54 ± 0.89	1.00 ± 0.20	1.50 ± 0.30	3.26 ± 0.71	3.72 ± 0.94
Percentage of inhibition or stimulation of seedling length	00.00	-77.97	-66.96	-28.20	-18.06
Mean number of lateral roots	0.20	00.00	00.00	00.00	00.00
Shoot vigour index	257.28	50.70	85.86	228.00	234.24
Root vigour index	178.56	43.30	35.64	81.70	122.88
Seedling vigour index	435.84	65.00	121.50	309.70	357.12
Shoot / root ratio	1.44	3.54	2.41	2.79	1.90

'+' = stimulation ; '-' = inhibition.

The seedling growth was adversely affected in different concentrations of extracts. Roots of seedlings were more affected than the shoots and no lateral root was initiated. Application of different concentrations of extracts, namely, 1:2.5, 1:5, 1:10 and 1:20 caused 70.89, 60.44, 10.45 and 8.95 % inhibition in shoot length

and 88.17, 76.34, 53.76 and 31.18 % inhibition in root length, respectively, as compared to control. Shoot vigour index, root vigour index and seedling vigour index were also lower in all concentrations of diluted extracts.

In the present study it was observed that under the all concentrations of extracts the shoot : root ratio of seedling were higher (3.54, 2.41, 2.79 and 1.90) than that of the control (1.44) causing more inhibition of root growth then shoot.

8.2.2.2. EFFECT OF EXTRACTS OF *Carex indica* ON SEED GERMINATION AND SEEDLING GROWTH OF *Streptocaulon sylvestre* WIGHT.

Effect of the extracts of whole plant of *Carex indica* on different parameters of seed germination and seedling growth of *Streptocaulon sylvestre* Wight are presented in Table-8.14. The pH of the different dilutions ranged from 4.66 to 6.88. Both germination and early growth of seedling were affected adversely by the extracts of this associate species. Germination percentage decreased linearly against the increased concentration of extracts. The percentage of germination was minimum (12.00 ± 1.63) with the highest concentration (1:2.5) of diluted extracts. It showed 87.50 % injurious toxic inhibitory effect. Moreover, extract concentrations of 1:5, 1:10 and 1:20 caused 61.46, 38.54 and 36.46 % decline in seed germination, respectively, as against control (96.00 ± 2.83).

It was observed that the index of speed of germination was adversely influenced by the application of extracts of this species. The highest concentration of extracts resulted in the slowest index of speed of germination of 0.99 ± 0.14 as against 19.56 ± 0.53 with control, which increased slowly along with the increased of dilution but also prominently inhibitory even at the lowest concentration of extracts (7.93 ± 0.31).

Observation on the effect of extracts on early growth of seedlings also showed similar effect as it was in case of germination. With extracts treatment not only the lateral root initiation but also the growth of shoot and root were inhibited adversely and were always less than that of the seedlings grown under controled condition. Treatments with extracts solutions, namely, 1:2.5, 1:5, 1:10, and 1:20 caused 87.69, 64.61, 59.23 and 57.69 % inhibition in shoot length and 89.09, 79.09, 60.00 and 53.64 % inhibition in root length, respectively, over the control. Moreover, the seedling vigour index, shoot vigour index and root vigour index were always lowest in all concentrations of extracts than that of control.

In this investigation it was observed that the shoot : root ratio of seedling did

Table 8.14. Effect of extracts of whole plant of *Carex indica* on different parameters of seed germination and seedling growth of *Streptocaulon sylvestre* Wight

PARAMETERS	CONCENTRATION OF SOLUTION				
	Control	1:2.5	1:5	1:10	1:20
Solution pH	7.00	4.66	5.85	6.55	6.88
Germination percentage	96.0 ±2.83	12.0 ± 1.63	37.0 ±3.41	59.0 ± 3.78	61.0 ± 4.43
Germination % inhibition or stimulation	00.00	-87.50	-61.46	-38.54	-36.46
Percentile of viability	100.00	12.50	38.54	61.46	63.35
Nonviable percentage	4.00	88.00	63.00	41.00	39.00
Index of speed of germination	19.56 ± 0.53	0.99 ± 0.14	4.10 ± 0.36	7.56 ± 0.33	7.93 ±0.31
Mean shoot length (cm) per seedling	2.60 ± 0.50	0.32 ± 0.05	0.92 ± 0.39	1.06 ± 0.35	1.10 ± 0.29
Percentage of inhibition or stimulation of shoot length	00.00	-87.69	-64.61	-59.23	-57.69
Mean root length (cm) per seedling	2.20 ± 0.46	0.24 ± 0.07	0.46 ± 0.10	0.88 ± 0.11	1.02 ± 0.12
Percentage of inhibition or stimulation of root length	00.00	-89.09	-79.09	-60.00	-53.64
Mean total length (cm) per seedling	4.80 ± 0.92	0.56 ± 0.12	1.38 ± 0.50	1.94 ± 0.43	2.12 ± 0.39
Percentage of inhibition or stimulation of seedling length	00.00	-88.33	-71.25	-59.58	-55.83
Mean number of lateral roots	0.60	00.00	00.00	00.00	00.00
Shoot vigour index	249.60	3.84	34.04	62.54	67.10
Root vigour index	211.20	2.88	17.02	51.92	62.22
Seedling vigour index	460.80	6.72	51.06	114.46	129.32
Shoot / root ratio	1.18	1.33	2.00	1.20	1.08

+ / - signs indicates stimulatory / inhibitory effects of leachates.

not show any major dissimilarities between shoot and root growth. Although, with the 1:5 dilution, the occurrence of higher shoot : root ratio indicated more inhibition of root growth than that of shoot.

8.2.2.3. EFFECT OF EXTRACTS OF *Cymbopogon pendulus* ON SEED GERMINATION AND SEEDLING GROWTH OF *Streptocaulon sylvestre* WIGHT.

Different parameters of seed germination and seedling growth of *Streptocaulon sylvestre* Wight under the influence of extracts of areal parts of *Cymbopogon pendulus* are recorded in Table-8.15. The pH of the different

Table 8.15. Different parameters of seed germination and seedling growth of *Streptocaulon sylvestre* Wight under the influence of extracts of areal parts of *Cymbopogon pendulus*.

PARAMETERS	CONCENTRATION OF SOLUTION				
	Control	**1:2.5**	**1:5**	**1:10**	**1:20**
Solution pH	7.00	5.10	7.85	8.07	8.15
Germination percentage	97.0 ±1.91	28.0 ± 5.88	74.0 ±4.16	96.0 ± 2.31	96.0 ± 1.63
Germination % inhibition or stimulation	00.00	-71.13	-23.71	-1.03	-1.03
Percentile of viability	100.00	28.86	76.29	98.97	98.97
Nonviable percentage	3.00	72.00	26.00	4.00	4.00
Index of speed of germination	19.31 ± 0.31	3.53 ± 0.57	15.08 ± 1.02	18.30 ± 1.61	19.96 ±0.15
Mean shoot length (cm) per seedling	2.70 ± 0.45	1.38 ± 0.33	2.06 ± 0.56	2.54 ± 0.63	3.42 ± 0.66
Percentage of inhibition or stimulation of shoot length	00.00	-48.88	-23.70	-5.92	+26.66
Mean root length (cm) per seedling	1.74 ± 0.22	0.50 ± 0.07	1.92 ± 0.61	2.08 ± 0.55	2.12 ± 0.44
Percentage of inhibition or stimulation of root length	00.00	-71.26	+10.34	+19.54	+21.84
Mean total length (cm) per seedling	4.44 ± 0.59	1.88 ± 0.39	3.98 ± 1.13	4.62 ± 1.06	5.54 ± 1.07
Percentage of inhibition or stimulation of seedling length	00.00	-57.66	-10.36	+4.05	+24.77
Mean number of lateral roots	0.20	00.00	00.00	0.60	1.40
Shoot vigour index	261.90	38.64	152.44	243.84	328.32
Root vigour index	168.78	14.00	142.08	199.68	203.52
Seedling vigour index	430.68	52.64	294.52	443.52	531.84
Shoot / root ratio	1.55	2.76	1.07	1.22	1.61

'+' = stimulation ; '-' = inhibition.

concentrations of extracts ranged from 5.10 to 8.15. In the present study reciprocal relationship between germination percentage and extracts concentration was observed. The highest concentration of 1:2.5 resulted in 71.13 % decline in seed germination over the control (97.00 ± 1.91 % germination). Besides, diluted extracts of 1:5, 1:10 and 1:20 caused 23.71, 1.03 and 1.03 % inhibition in seed germination in comparison with the control, respectively, which led to increase the percentile of viability (76.29, 98.97 and 98.97 %, respectively) along with the increase in dilution.

Increasing concentration of extracts gradually decreased the index of speed of germination, resulted in fastest (19.96 ± 0.15) index of speed of germination at the lowest concentration (1:20) and slowest index of speed of germination (3.53 ± 0.57) at the highest concentration as against 19.31 ± 0.31 with control.

The length of seedlings appeared to be promoted with the lower concentrations of extracts (i.e. 1:10 and 1:20). Root growth was stimulated more and lateral roots were also initiated. It was observed that there were 4.05 and 24.77 % stimulation in seedling length at 1:10 and 1:20 levels of dilution of the extracts, respectively, over the control. On the other hand, the 1:2.5 and 1:5 levels of dilution caused 57.66 and 10.36 % inhibition in seedling length, respectively. Seedling vigour index and root vigour index were higher at the dilutions of 1:10 and 1:20 and lower at 1:2.5 and 1:5 levels of solution. However, only the concentration of 1:20 exhibited higher shoot vigour index as against control.

In this investigation it was observed that shoot : root ratio of seedling was lower (1.07, 1.22 and 1.61) at all the lower concentrations of extracts (1:5, 1:10 and 1:20, respectively) causing better growth of root system. But in highest concentration (1:2.5) this ratio was increased (2.76) indicating more inhibition of root growth than shoot.

8.2.2.4. EFFECT OF EXTRACTS OF *Phyllanthus urinaria* ON SEED GERMINATION AND SEEDLING GROWTH OF *Streptocaulon sylvestre* WIGHT.

Table-8.16 presents the effect of extracts of whole plants of *Phyllanthus urinaria* on seed germination and seedling growth of *Streptocaulon sylvestre* Wight. The pH of the extract solutions ranged between 6.45 and 7.35.

Results reveal that extracts at different concentrations reduced the germination percentage in comparison to control. Reciprocal relationship between reduction of germination percentage and extract concentration was observed. The application of 1:2.5, 1:5, 1:10 and 1:20 dilutions caused 35.79, 28.42, 15.79 and

Table 8.16. Effect of extracts of whole plant of *Phyllanthus urinaria* on seed germination and seedling growth of *Streptocaulon sylvestre* Wight

PARAMETERS	CONCENTRATION OF SOLUTION				
	Control	**1:2.5**	**1:5**	**1:10**	**1:20**
Solution pH	7.00	6.45	6.47	7.35	7.22
Germination percentage	95.0 ±1.91	61.0 ± 5.00	68.0 ±4.32	80.0 ± 1.63	92.0 ± 2.83
Germination % inhibition or stimulation	00.00	-35.79	-28.42	-15.79	-3.15
Percentile of viability	100.00	64.21	71.58	84.21	96.84
Nonviable percentage	5.00	39.00	32.00	20.00	8.00
Index of speed of germination	18.87 ± 0.52	9.56 ± 0.77	10.74 ± 0.65	12.55 ± 0.35	13.73 ±0.79
Mean shoot length (cm) per seedling	2.52 ± 0.39	1.08 ± 0.29	1.44 ± 0.59	1.96 ± 0.51	2.42 ± 0.23
Percentage of inhibition or stimulation of shoot length	00.00	-57.14	-42.86	-22.22	-3.97
Mean root length (cm) per seedling	1.72 ± 0.24	0.88 ± 0.20	1.04 ± 0.34	1.22 ± 0.27	1.64 ± 0.48
Percentage of inhibition or stimulation of root length	00.00	-48.84	-39.53	-29.07	-4.65
Mean total length (cm) per seedling	4.24 ± 0.60	1.96 ± 0.47	2.48 ± 0.91	3.18 ± 0.77	4.06 ± 0.66
Percentage of inhibition or stimulation of seedling length	00.00	-53.77	-41.51	-25.00	-4.24
Mean number of lateral roots	0.20	00.00	00.00	0.40	00.00
Shoot vigour index	239.40	65.88	97.92	156.80	222.64
Root vigour index	163.40	53.68	70.72	97.60	150.88
Seedling vigour index	402.80	119.56	168.64	254.40	373.52
Shoot / root ratio	1.46	1.23	1.38	1.60	1.47

+ / - signs indicates stimulatory / inhibitory effects of leachates.

3.15 % inhibition in seed germination, respectively. Slow index of speed of germination i.e. 9.56 ± 0.77 was recorded at the highest concentration of extract (1:2.5) as against 18.87 ± 0.52 with control, yet it was 13.73 ± 0.79 with the lowest concentration of extracts (1:20).

Results of the effect of extracts on seedling growth also showed similar effect

as in case of germination. The length of root, shoot and seedlings reduced inversely under the influence of different dilutions of extract. Treatments with extract solutions, namely 1:2.5, 1:5, 1:10 and 1:20, resulted in 53.77, 41.51, 25.00 and 4.24 % decline in seedling length over the control, respectively. Seedling vigour index, root vigour index and shoot vigour index were also lower in all concentrations of extract. Lateral root initiation was found only in 1:10 concentration. Moreover, the shoot : root ratio of seedling did not indicate major dissimilarities in growth behaviour between shoot and root parts of seedlings.

8.2.2.5. EFFECT OF EXTRACTS OF *Prunella vulgaris* ON SEED GERMINATION AND SEEDLING GROWTH OF *Streptocaulon sylvestre* WIGHT.

The effect of extracts of areal parts of *Prunella vulgaris* on different parameters of seed germination and seedling growth of *Streptocaulon sylvestre* are presented in Table-8.17. The pH of the extract solutions ranged from 5.86 - 8.17. Results reveal that the process of seed germination was observed to be affected by the treatments of the extract. The germination percentage showed decline along with the increase of concentration of extract solutions. Higher concentration of extract of 1:2.5 showed more inhibitory effect (67.02 %) on the percentage of germination as well as on the percentile of viability. On the other hand, extracts of 1:5, 1:10 and 1:20 dilutions exhibited least inhibitory effect on seed germination caused 21.27, 12.76 and 4.25 % decline as against 94.00 ± 2.58 with control, respectively.

The 1:2.5 dilution of extracts showed slowest index of speed of germination, 3.30 ± 0.43, and with subsequent dilutions (i.e. 1:5, 1:10and 1:20) it was increased to 12.22 ± 0.29, 13.95 ± 0.28 and 16.64 ± 0.16, respectively, while the index of speed of germination was 18.88 ± 0.51 under control.

The effect of extracts on the growth of seedlings revealed that both shoot and root length were considerably inhibited in almost all concentrations (Plate-VIII). Only the shoot length and seedling length were slightly stimulated (15.03 and 4.17 % respectively) at 1:20 dilution of the extracts over the control. Application of highest concentration (1:2.5) caused a decline of 67.91 % in seedling length as against control. However, lateral roots were also initiated at lower concentrations. Shoot vigour index was more at the concentration of 1:20 but it was less with all other concentrations. Although seedling vigour index and root vigour index were lower in all concentrations of extract as compared to control. Moreover, in all concentrations of extract, shoot : root ratio of seedling was slightly increased (1.85, 1.81, 1.87 and 1.58) over the control (1.24), indicating inhibition of root growth in comparison to shoot growth.

Table 8.17. Effect of extracts of areal parts of *Prunella vulgaris* on different parameters of seed germination and seedling growth of *Streptocaulon sylvestre* Wight

PARAMETERS	CONCENTRATION OF SOLUTION				
	Control	1:2.5	1:5	1:10	1:20
Solution pH	7.00	5.86	7.93	8.10	8.17
Germination percentage	94.0 ± 2.58	31.0 ± 4.12	74.0 ±1.15	82.0 ± 2.58	90.00 ± 3.46
Germination % inhibition or stimulation	00.00	-67.02	-21.27	-12.76	-4.25
Percentile of viability	100.00	32.98	78.72	87.23	95.74
Nonviable percentage	6.00	69.00	26.00	18.00	10.00
Index of speed of germination	18.88 ± 0.51	3.30 ± 0.43	12.22 ± 0.29	13.95 ± 0.28	16.64 ±0.16
Mean shoot length (cm) per seedling	2.66 ± 0.37	1.00 ± 0.33	1.92 ± 0.58	2.54 ± 0.38	3.06 ± 0.48
Percentage of inhibition or stimulation of shoot length	00.00	-62.40	-27.82	-4.51	+15.04
Mean root length (cm) per seedling	2.14 ± 0.22	0.54 ± 0.12	1.06 ± 0.33	1.36 ± 0.21	1.94 ± 0.35
Percentage of inhibition or stimulation of root length	00.00	-74.77	-50.47	-36.45	-9.34
Mean total length (cm) per seedling	4.80 ± 0.39	1.54 ± 0.43	2.98 ± 0.90	3.90 ± 0.54	5.00 ± 0.78
Percentage of inhibition or stimulation of seedling length	00.00	-67.91	-37.91	-18.75	+4.17
Mean number of lateral roots	0.40	00.00	00.00	0.80	1.00
Shoot vigour index	250.04	31.00	142.08	208.26	275.40
Root vigour index	201.16	16.74	78.44	111.52	174.60
Seedling vigour index	451.20	47.74	220.52	319.80	450.00
Shoot / root ratio	1.24	1.85	1.81	1.87	1.58

+ / - signs indicates stimulatory / inhibitory effects of leachates.

8.2.2.6. EFFECT OF EXTRACTS OF *Pueraria phaseoloides* ON SEED GERMINATION AND SEEDLING GROWTH OF *Streptocaulon sylvestre* WIGHT.

Effect of extracts of different concentrations of areal parts of *Pueraria phaseoloides* on seed germination and seedling growth of *Streptocaulon sylvestre*

Wight are given in Table-8.18. The pH of the extract solutions ranged between 4.30 and 4.63.

In the present investigation it was observed that extracts of *P. phaseoloides* showed strong injurious effect on seed germination and seedling growth of *S sylvestre.* (PLate-VIII)

Table 8.18. Different parameters of seed germination and seedling growth of *Streptocaulon sylvestre* Wight under the influence of extracts of areal parts of *Pueraria phaseoloides.*

PARAMETERS	CONCENTRATION OF SOLUTION				
	Control	1:2.5	1:5	1:10	1:20
Solution pH	7.00	4.30	4.45	4.57	4.63
Germination percentage	97.0 ±1.91	Nil	Nil	Nil	5.00 ± 1.00
Germination %inhibition or stimulation	00.00	-100.00	-100.00	-100.00	-94.84
Percentile of viability	100.00	00.00	00.00	00.00	5.15
Nonviable percentage	3.00	100.00	100.00	100.00	95.00
Index of speed of germination	19.31 ± 0.31	00.00	00.00	00.00	0.41 ±0.09
Mean shoot length (cm) per seedling	2.70 ± 0.45	Nil	Nil	Nil	0.20 ± 0.03
Percentage of inhibition or stimulation of shoot length	00.00	-100.00	-100.00	-100.00	-92.59
Mean root length (cm) per seedling	1.74 ± 0.22	Nil	Nil	Nil	0.16 ± 0.02
Percentage of inhibition or stimulation of root length	00.00	-100.00	-100.00	-100.00	-90.80
Mean total length (cm) per seedling	4.44 ± 0.59	Nil	Nil	Nil	0.36 ± 0.05
Percentage of inhibition or stimulation of seedling length	00.00	-100.00	-100.00	-100.00	-91.89
Mean number of lateral roots	0.20	00.00	00.00	00.00	00.00
Shoot vigour index	261.90	00.00	00.00	00.00	1.00
Root vigour index	168.78	00.00	00.00	00.00	0.80
Seedling vigour index	430.68	00.00	00.00	00.00	1.80
Shoot / root ratio	1.55	Nil	Nil	Nil	1.25

'+' = stimulation ; '-' = inhibition.

Moreover at higher concentrations, namely 1:2.5, 1:5 & 1:10, not a single seed was germinated. With lowest concentration (1:20), however, germination occurred, but percentage was negligible (5.0 ± 1.00 %) and the index of speed of germination was extremely low (0.41± 0.09).

Seedling growth was strongly inhibited caused 91.89 % decline in length. Sizes of shoots and roots were very small. Besides, the shoot : root ratio of seedling was 1.25 at 1:20 dilution of extracts. Seedling vigour index, root vigour index and shoot vigour index were also very low (almost negligible) at the viable concentration. However, it was observed that extracts of *P. phaseoloides* strongly inhibited the germination of seed and early growth of seedling of *S. sylvestre* Wight at all concentrations.

8.2.2.7. EFFECT OF EXTRACTS OF *Rungia pectinata* ON SEED GERMINATION AND SEEDLING GROWTH OF *Streptocaulon sylvestre* WIGHT.

Effect of different concentrations of extracts of whole plant of *Rungia pectinata* on seed germination and seedling growth of *Streptocaulon sylvestre* Wight are presented in Table-8.19. The pH of the extract solutions ranged from 6.25 to 8.24. From the perusal of the obtained data, it is apparent that highest concentration of extracts (1:2.5) exhibited much inhibitory effect on the percentage of seed germination caused 50.00 % reduction over the control (96.00 ± 2.83 %). Later on, diluted extracts, namely 1:5, 1:10 and 1:20, showed 16.66, 9.37 and 5.20 % inhibition in seed germination, respectively, as compared with control.

In this investigation, the highest concentration of extracts (1:2.5) showed quite slow index of speed of germination of 7.34 ± 0.60, whereas, rest of the dilutions (i.e. 1:5, 1:10 and 1:20) exhibited the index of speed of germination of 14.78 ± 0.38, 16.17 ± 0.47 and 17.45 ± 0.46, respectively, showing less inhibition over the control (19.56 ± 0.53).

However, it was observed that effect of different concentrations of extracts on seedling growth parameters were different. Growth tendency of shoot and root were not alike. Application of different dilutions of extract, namely 1:5, 1:10 and 1:20 caused 13.08, 23.85 and 18.46 % stimulation in shoot length and, at the same time, 49.10, 14.54 and 11.81 % inhibition in root length as against control, respectively. Lateral roots were produced under all lower concentrations. Besides shoot vigour index was higher at concentrations of 1:10 and 1:20 but it was lower at concentrations of 1:2.5 and 1:5. Moreover, seedling vigour index and root vigour index were lower in all concentrations of extracts in comparism with control.

Table 8.19. Effect of extracts of whole plant of *Rungia pectinata* on seed germination and seedling growth of *Streptocaulon sylvestre* Wight

PARAMETERS	CONCENTRATION OF SOLUTION				
	Control	1:2.5	1:5	1:10	1:20
Solution pH	7.00	6.25	7.82	8.10	8.24
Germination percentage	96.0 ±2.83	48.0 ± 5.65	80.0 ±2.83	87.0 ± 4.12	91.00 ±1.00
Germination % inhibition or stimulation	00.00	-50.00	-16.66	-9.37	-5.20
Percentile of viability	100.00	50.00	83.33	90.62	94.79
Nonviable percentage	4.00	52.00	20.00	13.00	9.00
Index of speed of germination	19.56 ± 0.53	7.34 ± 0.60	14.78 ± 0.38	16.17 ± 0.47	17.45 ±0.46
Mean shoot length (cm) per seedling	2.60 ± 0.50	1.92 ± 0.47	2.94 ± 0.62	3.22 ± 0.41	3.08 ± 0.36
Percentage of inhibition or stimulation of shoot length	00.00	-26.15	+13.08	+23.85	+18.46
Mean root length (cm) per seedling	2.20 ± 0.46	0.66 ± 0.09	1.12 ± 0.23	1.88 ± 0.28	1.94 ± 0.23
Percentage of inhibition or stimulation of root length	00.00	-70.00	-49.10	-14.54	-11.82
Mean total length (cm) per seedling	4.80 ± 0.92	2.58 ± 0.55	4.06 ± 0.85	5.10 ± 0.58	5.02 ± 0.47
Percentage of inhibition or stimulation of seedling length	00.00	-46.25	-15.41	+6.25	+4.58
Mean number of lateral roots	0.60	00.00	0.40	1.00	1.00
Shoot vigour index	249.60	92.16	235.20	280.14	280.28
Root vigour index	211.20	31.68	89.60	163.56	176.54
Seedling vigour index	460.80	123.84	324.80	443.70	456.82
Shoot / root ratio	1.18	2.91	2.62	1.71	1.58

'+' = stimulation ; '-' = inhibition.

In all concentrations, shoot : root ratio of seedling was generally higher (2.91, 2.62, 1.71 and 1.58) than that of control (1.18), indicating the inhibition of root growth as compared to the growth of shoot.

8.2.3. EFFECT OF MIXTURE OF LEACHATES

The present study exhibits the effect of mixture of leachates of eight common associate species, viz *Borreria alata, Cymbopogon pendulus, Elephantopus scaber, Desmodium triflorum, Mitracarpus verticillatus, Pueraria phaseoloides, Saccharum spontaneum* and *Sporobolus indicus,* on different parameters of seed germination and seedling growth of *Streptocaulon sylvestre.*

8.2.3.1. EFFECT OF MIXTURE OF LEACHATES OF *Borreria alata* AND *Cymbopogon pendulus* ON SEED GERMINATION AND SEEDLING GROWTH OF *Streptocaulon sylvestre* WIGHT.

Effect of mixture of leachates of areal parts of *Borreria alata* and *Cymbopogon pendulus* on seed germination and seedling growth of *Streptocaulon sylvestre* Wight are shown in Table-8.20. The pH of the mixed solutions ranged between 8.07 and 8.23. Results indicate that when leachates of *Cymbopogon pendulus* was applied in combination with the leachates of *Borreria alata* in different concentrations no major variation was observed in germination percentage and index of speed of germination as compared to their individual effects (Table-8.1 and 8.2). Only at highest concentration (1:2.5) promotory effect was observed in germination percentage (72.00 ± 4.32 %) and in index of speed of germination (14.64 ± 0.93) as compared to the individual effect of *C. pendulus* (Table- 8.2).

The length of shoot and root of the seedlings varied markedly under the influence of different dilutions of mixture of leachates. At highest concentration (1:2.5) of mixed leachates the average seedling length was 1.64 ± 0.58 cm, whereas at the same concentration of leachates of *C. pendulus* and *B. alata* average seedling length was 2.40 ± 0.58 and 1.18 ± 0.47 cm, respectively (Table- 8.1 & 8.2). At lowest concentration (1:20) this figure was 5.54 ± 1.50 cm in mixture, 5.82 ± 1.24 cm in *C. pendulus* and 3.78 ± 1.12 cm in *B. alata*. Moreover, for control this figure was 4.54 ± 0.89 cm. Shoot vigour index and seedling vigour index were more at concentration of 1:20 but were less with all other concentrations over the control. Besides, root vigour index was more at concentrations of 1:10 and 1:20 and less at concentrations of 1:2.5 and 1:5.

The shoot:root ratio of seedling was lower (1.36, 1.07 and 1.02) with all lower concentrations of mixed leachates (1:5, 1:10 and 1:20 respectively) as comparable to control (1.44), causing better root growth of seedling than shoot. But with the highest concentration (1:2.5) this ratio was increased much (6.45), indicating a strong inhibition of root growth.

Table 8.20. Effect of mixture of leachates of areal parts of *Borreria alata* and *Cymbopogon pendulus* on seed germination and seedling growth of *Streptocaulon sylvestre* Wight

PARAMETERS	CONCENTRATION OF SOLUTION				
	Control	**1:2.5**	**1:5**	**1:10**	**1:20**
Solution pH	7.00	8.07	8.20	8.15	8.23
Germination percentage	96.0 ±1.63	72.0 ± 4.32	89.0 ±3.00	96.0 ± 1.63	96.00 ± 2.83
Germination % inhibition or stimulation	00.00	-25.00	-7.29	00.00	00.00
Percentile of viability	100.00	75.00	92.71	100.00	100.00
Nonviable percentage	4.00	28.00	11.00	4.00	4.00
Index of speed of germination	20.13 ± 0.35	14.64 ± 0.93	18.79 ± 0.24	19.43 ± 0.22	19.50 ±1.07
Mean shoot length (cm) per seedling	2.68 ± 0.62	1.42 ± 0.55	1.50 ± 0.59	2.02 ± 0.52	2.80 ± 0.78
Percentage of inhibition or stimulation of shoot length	00.00	-47.01	-44.03	-24.63	+4.48
Mean root length (cm) per seedling	1.86 ± 0.30	0.22 ± 0.04	1.10 ± 0.29	1.88 ± 0.71	2.74 ± 0.81
Percentage of inhibition or stimulation of root length	00.00	-88.17	-40.86	+1.07	+47.31
Mean total length (cm) per seedling	4.54 ± 0.89	1.64 ± 0.58	2.60 ± 0.79	3.90 ± 0.97	5.54 ± 1.50
Percentage of inhibition or stimulation of seedling length	00.00	-63.87	-42.73	-14.10	+22.02
Mean number of lateral roots	0.20	00.00	00.00	00.00	1.00
Shoot vigour index	257.28	102.24	133.50	193.92	268.80
Root vigour index	178.56	15.84	97.90	180.48	263.04
Seedling vigour index	435.84	188.08	231.40	374.40	531.84
Shoot / root ratio	1.44	6.45	1.36	1.07	1.02

+ / - signs indicates stimulatory / inhibitory effects of leachates.

8.2.3.2. EFFECT OF MIXTURE OF LEACHATES OF *Cymbopogon pendulus* AND *Elephantopus scaber* on seed germination and seedling growth of *Streptocaulon sylvestre* WIGHT.

Table-8.21 demonstrates the effect of mixture of leachates of areal parts of *Cymbopogon pendulus* and whole plant of *Elephantopus scaber* on seed germination

and seedling growth of *Streptocaulon sylvestre* Wight. The pH of mixed leachates ranged from 8.10 to 8.34. It was observed that the combination of leachates of *Elephantopus scaber* and *Cymbopogon pendulus* showed almost equal effect in

Table 8.21. Effect of mixture of leachates of areal parts of *Cymbopogon pendulus* and whole plant of *Elephantopus scaber* on seed germination and seedling growth of *Streptocaulon sylvestre* Wight

PARAMETERS	CONCENTRATION OF SOLUTION				
	Control	1:2.5	1:5	1:10	1:20
Solution pH	7.00	8.10	8.23	8.20	8.34
Germination percentage	96.0 ± 1.63	82.0 ± 2.58	87.0 ± 2.51	96.0 ± 2.31	96.00 ± 1.63
Germination % inhibition or stimulation	00.00	-14.58	-9.37	00.00	00.00
Percentile of viability	100.00	85.42	90.62	100.00	100.00
Nonviable percentage	4.00	18.00	13.00	4.00	4.00
Index of speed of germination	20.13 ± 0.35	13.39 ± 0.29	17.39 ± 0.31	19.59 ± 0.29	19.87 ± 0.14
Mean shoot length (cm) per seedling	2.68 ± 0.62	1.90 ± 0.54	3.02 ± 0.73	3.12 ± 0.76	3.10 ± 0.57
Percentage of inhibition or stimulation of shoot length	00.00	-29.10	+12.69	+16.42	+15.67
Mean root length (cm) per seedling	1.86 ± 0.30	0.86 ± 0.23	1.60 ± 0.45	2.28 ± 0.51	2.02 ± 0.38
Percentage of inhibition or stimulation of root length	00.00	-53.76	-13.98	+22.58	+8.60
Mean total length (cm) per seedling	4.54 ± 0.89	2.76 ± 0.67	4.62 ± 1.13	5.40 ± 1.17	5.12 ± 0.73
Percentage of inhibition or stimulation of seedling length	00.00	-39.20	+1.76	+18.94	+12.77
Mean number of lateral roots	0.20	00.00	0.40	1.20	1.20
Shoot vigour index	257.28	155.80	262.74	299.52	297.60
Root vigour index	178.56	70.52	139.20	218.88	193.92
Seedling vigour index	435.84	226.32	401.94	518.40	491.52
Shoot / root ratio	1.44	2.21	1.88	1.37	1.53

+ / - signs indicates stimulatory / inhibitory effects of leachates.

germination percentage at all lower concentrations (1:5, 1:10 and 1:20) in comparison to their effects when used individually (Table-8.2 and 8.4). At the highest concentration (1:2.5) this mixed leachates increased the percentage of germination to 82.00 ± 2.51, from that of the leachates of *C. pendulus* and *E. scaber* when used separately (50.00 ± 2.58 and 57.00 ± 3.41 %, respectively). The index of speed of germination was also increased (13.39 ± 0.29) at the highest concentration of mixed leachates (1:2.5) as compared to their individual effects (Table- 8.2 & 8.4), though slight variation was observed for all the lower concentratons of leachates.

The value of early seedling development followed a similar pattern of response as for the germination (Plate-VIII). It was markedly enhanced in almost all concentrations of mixed leachates except only the highest concentration of leachates (1:2.5) which retarded 39.20 % elongation of seedlings over control. Although *C. pendulus* and *E. scaber* showed inhibitory effect on seedling growth in corresponding concentration, when used alone. Application of mixed leachates of 1:5, 1:10 and 1:20 obtained 1.76, 18.94 and 12.77 % stimulation in seedling length over the control, respectively. Furthermore, lateral roots were initiated with almost all concentrations except at 1:2.5 dilution. Root vigour index and seedling vigour index were higher at concentrations of 1:10 and 1:20 but they were lower at concentrations of 1:2.5 and 1:5. On the otherhand, shoot vigour index was higher at concentrations of 1:5, 1:10 and 1:20 and lower at concentration of 1:2.5 as compared to control.

In the present investigation it was observed that at highest concentration of mixed leachates (1:2.5) the shoot:root ratio of seedling was higher (2.21) than that of control (1.44), indicating more inhibition of root growth as compared to shoot growth. But in all other lower concentrations (1:5, 1:10 and 1:20) shoot : root ratio was exhibited with slight variation only.

8.2.3.3. EFFECT OF MIXTURE OF LEACHATES OF *Cymbopogon pendulus* AND *Pueraria phaseoloides* ON SEED GERMINATION AND SEEDLING GROWTH OF *Streptocaulon sylvestre* WIGHT.

Results of the treatments of mixed leachates from areal parts of *Cymbopogon pendulus* and *Pueraria phaseoloides* on different parameters of seed germination and seedling growth of *Streptocaulon sylvestre* Wight are presented in Table- 8.22. The pH of the mixed leachates solutions ranged between 4.70 and 5.60.

It was observed from Table-8.9 and 8.2 that leachates of *Pueraria phaseoloides* showed injurious effect and leachates of *Cymbopogon pendulus*

Table 8.22. Effect of mixture of leachates of areal parts of *Cymbopogon pendulus* and *Pueraria phaseoloides* on different parameters of seed germination and seedling growth of *Streptocaulon sylvestre* Wight

PARAMETERS	CONCENTRATION OF SOLUTION				
	Control	1:2.5	1:5	1:10	1:20
Solution pH	7.00	4.70	4.85	5.26	5.60
Germination percentage	97.0 ±1.91	Nil	Nil	7.00 ± 1.77	21.00 ± 2.51
Germination % inhibition or stimulation	00.00	-100.00	-100.00	-92.78	-78.35
Percentile of viability	100.00	00.00	00.00	7.22	21.65
Nonviable percentage	3.00	100.00	100.00	93.00	79.00
Index of speed of germination	19.31 ± 0.31	00.00	00.00	0.82 ± 0.20	2.47 ±0.25
Mean shoot length (cm) per seedling	2.70 ± 0.45	Nil	Nil	0.30 ± 0.05	1.16 ±0.34
Percentage of inhibition or stimulation of shoot length	00.00	-100.00	-100.00	-88.88	-57.04
Mean root length (cm) per seedling	1.74 ± 0.22	Nil	Nil	0.22 ± 0.05	0.40 ± 0.11
Percentage of inhibition or stimulation of root length	00.00	-100.00	-100.00	-87.35	-77.01
Mean total length (cm) per seedling	4.44 ± 0.59	Nil	Nil	0.52 ± 0.10	1.56 ± 0.29
Percentage of inhibition or stimulation of seedling length	00.00	-100.00	-100.00	-88.29	-64.86
Mean number of lateral roots	0.20	00.00	00.00	00.00	00.00
Shoot vigour index	261.90	00.00	00.00	2.10	24.36
Root vigour index	168.78	00.00	00.00	1.54	8.40
Seedling vigour index	430.68	00.00	00.00	3.64	32.76
Shoot / root ratio	1.55	Nil	Nil	1.36	2.90

'+' = stimulation ; '-' = inhibition.

showed better performence in seed germination and seedling growth. When leachates of *P. phaseoloides* was applied in combination with leachates of *C. pendulus*, it was seen that (Table-8.22) the inhibitory effect of *P. phaseoloides* could not be changed (Plate-VIII). Rather promotory effect of *C. pendulus* was suppressed. Even in

EXPLANATIONS OF PHOTOGRAPHS

Plate VIII.

Allelopathic effects of commonly associated plants of *Streptocaulon sylvestre* Wight [Dilutions: A= Control; B= 1: 2.5; C= 1: 5; D= 1: 10; E = 1: 20]

Photo 1. Effects with the extracts of *Prunella vulgaris* in different concentrations.

Photo 2. Effects with the mixture of leachates of *Pueraria phaseoloides* and *Cymbopogon pendulus* in different concentrations.

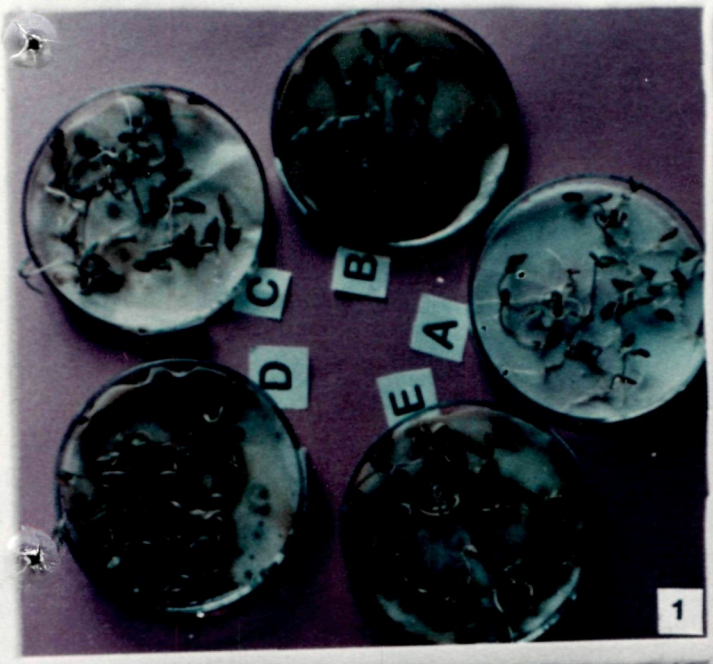
Photo 3. Effects with the leachates of *Mitracarpus verticillatus* in different concentrations.

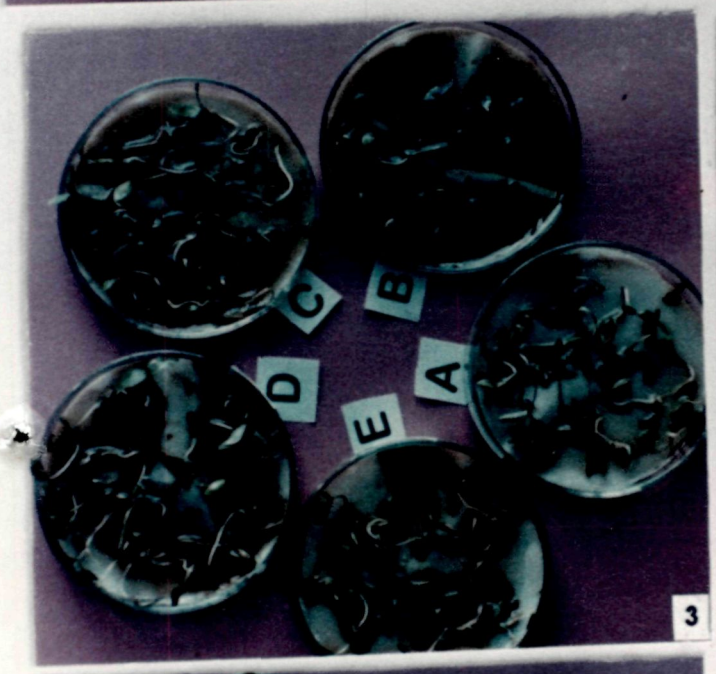
Photo 4. Effects with the mixture of leachates of *Cymbopogon pendulus* and *Elephantopus scaber* in different concentrations.

Photo 5. Effects with the leachates of *Vernonia cinerea* in different concentrations.

Photo 6. Effects with the extracts of *Pueraria phaseoloides* in different concentrations.

PLATE VIII





the highest dilution (1:20) of mixed leachates, germination percentage and seedling growth was highly reduced. Although mixed leachates at lower concentrations (1:10 and 1:20) slightly increased the percentage of germination (7.00 ± 1.77 and 21.00 ± 2.51) in comparison to the germination percentage in leachates of *P. phaseoloides* (5.00 ± 1.00 and 8.0 ± 2.31 %) but seedling growth was much inhibited.

The index of speed of germination was also very slow in mixed leachates. In addition, shoot vigour index, root vigour index and seedling vigour index were also very low under the mixed leachates. Besides, the shoot : root ratio of seedling was higher (2.90) at the lowest concentration (1:20) of mixed leachates than that of control (1.71) causing more inhibition of root growth as compared to shoot.

8.2.3.4. EFFECT OF MIXTURE OF LEACHATES OF *Borreria alata, Cymbopogon pendulus* AND *Desmodium triflorum* ON SEED GERMINATION AND SEEDLING GROWTH OF *Streptocaulon sylvestre* WIGHT.

Data on the effect of mixed leachates of areal parts of *Borreria alata* and *Cymbopogon pendulus* and whole plant of *Desmodium triflorum* on seed germination and seedling growth of *Streptocaulon sylvestre* Wight are shown in Table- 8.23. The pH of the mixed leachates ranged from 6.20 to 8.15.

It was seen from table 8.1 and 8.2 that leachates of *Borreria alata* and *Cymbopogon pendulus* showed better performence in seed germination when used alone. But the leachates of *Desmodium triflorum* reduced the percentage of germination (Table- 8.3), even at highest concentration (1:2.5) it exhibited deleterious effect. In the present investigation it was found that leachates of *D. triflorum* in combination with leachates of *B. alata* and *C. pendulus* also showed deleterious effect on germination percentage in highest concentration (1:2.5) where not a single seed was germinated (Table-8.23). But the diluted concentrations of mixed leachates of 1:5, 1:10 and 1:20 showed the germination percentage to 71.00 ± 3.41, 81.00 ± 4.12 and 89.00 ± 1.91, respectively, which were higher than the individual effect of *D. triflorum* and lower than the individual effect of *B. alata* and *C. pendulus*. This observation showed that the inhibitory effect of *D. triflorum* was not reduced in combination with *B. alata* and *C. pendulus* at highest concentration (1:2.5) but with further dilution the inhibitory effect on germination was gradually decreased. A similar trend of response was also observed in the index of speed of germination. The concentrations of 1:5, 1:10 and 1:20 of mixed leachates showed the index of speed of germination of 11.56 ± 0.23, 13.45 ± 0.40 and 16.60 ± 0.27 as against 19.42 ± 0.64 with control, respectively.

Table 8.23. Effect of mixture of leachates of areal parts of *Borreria alata & Cymbopogon pendulus* and whole plant of *Desmodium triflorum* on different parameters of seed germination and seedling growth of *Streptocaulon sylvestre* Wight

PARAMETERS	CONCENTRATION OF SOLUTION				
	Control	1:2.5	1:5	1:10	1:20
Solution pH	7.00	6.20	7.35	8.07	8.15
Germination percentage	97.0 ±3.00	Nil	71.00 ± 3.41	81.00 ± 4.12	89.00 ± 1.91
Germination % inhibition or stimulation	00.00	-100.00	-26.80	-16.49	-8.25
Percentile of viability	100.00	00.00	73.19	83.50	91.75
Nonviable percentage	3.00	100.00	29.00	19.00	11.00
Index of speed of germination	19.42 ± 0.64	Nil	11.56 ± 0.23	13.45 ± 0.40	16.60 ±0.27
Mean shoot length (cm) per seedling	2.80 ± 0.45	Nil	1.86 ± 0.55	2.24 ± 0.34	3.00 ±0.20
Percentage of inhibition or stimulation of shoot length	00.00	-100.00	-33.57	-20.00	+7.14
Mean root length (cm) per seedling	1.94 ± 0.41	Nil	1.50 ± 0.48	1.88 ± 0.42	1.86 ± 0.34
Percentage of inhibition or stimulation of root length	00.00	-100.00	-22.68	-3.09	-4.12
Mean total length (cm) per seedling	4.74 ± 0.73	Nil	3.36 ± 1.03	4.12 ± 0.73	4.86 ± 0.49
Percentage of inhibition or stimulation of seedling length	00.00	-100.00	-29.11	-13.08	+2.53
Mean number of lateral roots	0.40	00.00	1.60	0.40	1.80
Shoot vigour index	271.60	00.00	132.06	181.44	267.00
Root vigour index	188.18	00.00	106.50	152.28	165.54
Seedling vigour index	459.78	00.00	238.56	333.72	432.54
Shoot / root ratio	1.44	Nil	1.24	1.19	1.61

+ / - signs indicates stimulatory / inhibitory effects of leachates.

The maximum seedling length for mixed leachates was obtained at lowest concentration of 1:20 (4.86 ± 0.49 cm) which showed 2.53 % stimulation over the control (4.74 ± 0.73 cm). On the other hand , at the same concentration, *C.pendulus,*

B. alata and *D. triflorum* brought about the maximum seedling length of 5.82 ± 1.24, 3.78 ± 1.12 and 4.26 ± 1.45 cm, respectively, when used alone. Similarly, higher concentration of mixed leachates of 1:5 produced shortest seedling of 3.36 ± 1.03 cm caused 29.11 % inhibition over control. Whereas in the corresponding concentration *C.pendulus, B. alata* and *D. triflorum,* individually, obtained seedling length of 4.64 ± 1.46, 1.96 ± 0.62 and 2.06 ± 0.60 cm, respectively. This observation revealed that seedling elongation was recovered from the inhibitory effect of leachates of *B. alata* and *D. triflorum* when used in combination with the leachates of *C.pendulus.*

Besides, lateral roots were initiated in all viable concentrations of mixed leachates. Although shoot vigour index, root vigour index and seedling vigour index were also lower in mixed leachates. Moreover, the shoot : root ratio of seedling of viable concentrations of mixed leachates did not indicate any remarkable dissimilarities between shoot and root growth in comparison to the control.

8.2.3.5. EFFECT OF MIXTURE OF LEACHATES OF *Cymbopogon pendulus, Saccharum spontaneum* AND *Sporobolus indicus* ON SEED GERMINATION AND SEEDLING GROWTH OF *Streptocaulon sylvestre* WIGHT.

Effect of mixture of leachates of areal parts of *Cymbopogon pendulus & Saccharum spontaneum* and whole plants of *Sporobolus indicus* on seed germination and seedling growth of *Streptocaulon sylvestre* Wight are given in Table-8.24. The pH of mixture dilutions ranged from 5.10 to 8.35.

Results reveal that highest concentration of mixed leachates (1:2.5) showed more inhibitory effect on the percentage of germination (21.00 ± 4.12) caused 77.90 % inhibition over the control (95.00 ± 2.51). Thereafter, with further dilutions (i.e 1:5, 1:10 and 1:20) germination percentage was increased to 82.00 ± 1.15, 90.00 ± 4.16 and 93.00 ± 2.52 %, respectively, leading to 13.68, 5.26 and 2.10 % inhibition as against control. This observation showed that inhibitory effect of *Saccharum spontaneum* (Table- 8.10) was slightly decreased in combination with *Cymbopogan pendulus* and *Sporobolus indicus* at highest concentration, as well as the effect of *C. pendulus* (Table- 8.2) was found to be inhibited in corresponding concentrations.

Very slow index of speed of germination (2.31 ± 0.40) was recorded at the highest concentration of mixed leachates (1:2.5) and subsequently it was increased

Table 8.24. Effect of mixture of leachates of areal parts of *Cymbopogon pendulus* & *Saccharum spontaneum* and whole plant of *Sporobolus indicus* on seed germination and seedling growth of *Streptocaulon sylvestre* Wight

PARAMETERS	CONCENTRATION OF SOLUTION				
	Control	1:2.5	1:5	1:10	1:20
Solution pH	7.00	5.10	7.40	8.25	8.35
Germination percentage	95.0 ± 2.51	21.00 ± 4.12	82.00 ± 1.15	90.00 ± 4.16	93.00 ± 2.52
Germination %inhibition or stimulation	00.00	-77.90	-13.68	-5.26	-2.10
Percentile of viability	100.00	22.10	86.31	94.74	97.89
Nonviable percentage	5.00	79.00	18.00	10.00	7.00
Index of speed of germination	19.00 ± 0.69	2.31 ± 0.40	12.34 ± 0.46	14.58 ± 0.40	14.83 ±0.27
Mean shoot length (cm) per seedling	2.70 ± 0.58	0.64 ± 0.12	2.26 ± 0.37	2.58 ± 0.60	2.56 ±0.28
Percentage of inhibition or stimulation of shoot length	00.00	-76.29	-16.29	-4.44	-5.18
Mean root length (cm) per seedling	1.56 ± 0.30	0.40 ± 0.07	1.78 ± 0.35	1.80 ± 0.40	1.98 ± 0.30
Percentage of inhibition or stimulation of root length	00.00	-74.35	+14.10	+15.38	+26.92
Mean total length (cm) per seedling	4.26 ± 0.88	1.04 ± 0.17	4.04 ± 0.45	4.38 ± 0.98	4.54 ± 0.55
Percentage of inhibition or stimulation of seedling length	00.00	-75.58	-5.16	+2.81	+6.57
Mean number of lateral roots	0.20	00.00	0.80	2.20	0.80
Shoot vigour index	256.50	13.44	185.32	232.20	238.08
Root vigour index	148.20	8.40	145.96	162.00	184.14
Seedling vigour index	404.70	21.84	331.28	394.20	422.22
Shoot / root ratio	1.73	1.60	1.27	1.43	1.29

'+' = stimulation ; '-' = inhibition.

with gradually diluted leachates. At minimum concentration of 1:20 this rate was 14.83 ± 0.27 which was also slow in comparison with the individual effects of *C. pendulus* or *S. spontaneum* or *S. indicus*.

Observation on the effects of mixture of leachates on seedling growth also

followed a similar pattern of response as for germination. Application of mixed leachates of 1:2.5, 1:5 and 1:10 showed average shoot length of 0.64 ± 0.12, 2.26 ± 0.37 and 2.58 ± 0.60 cm and average root length of 0.40 ± 0.07, 1.78 ± 0.35 and 1.80 ± 0.40 cm, respectively. These shoot and root lengths were found to be longer than the shoot and root length of leachate treatments of *S. spontaneum* (Table-8.10) and found to be shorter than the shoot and root length of leachate treatments of *C. pendulus* and *S. indicus* in corresponding concentrations (Table- 8.2 and 8.11). This observation showed that shoot and root growth of seedling was recovered from the inhibitory effect of leachates of *S. spontaneum* when used in mixture with the leachates of *C. pendulus* and *S. indicus.*

Lateral roots were also initiated in almost all concentrations of mixed leachates except at 1:2.5. The shoot vigour index were lower in all concentrations of mixed leachates. But seedling vigour index and root vigour index were higher at 1:20 dilution of mixed leachates. The shoot : root ratio of seedling (1.60, 1.27, 1.43 and 1.29) at the concentrations of 1:2.5, 1:5, 1:10 and 1:20, respectively, were lower than that of control (1.73) indicating better growth of root system in comparison with shoot system.

8.2.3.6. EFFECT OF MIXTURE OF LEACHATES OF *Borreria alata, Mitracarpus verticillatus, Pueraria phaseoloides* AND *Sporobolus indicus* ON SEED GERMINATION AND SEEDLING GROWTH OF *Streptocaulon sylvestre* WIGHT.

Table- 8.25 exhibits the effect of mixed leachates of areal parts of *Borreria alata, Mitracarpus verticillatus & Pueraria phaseoloides* and whole plants of *Sporobolus indicus* on seed germination and seedling growth of *Streptocaulon sylvestre* Wight. The pH of mixed leachates ranged between 4.70 and 7.64. From the perusal of the obtained results, it is evident that higher concentrations of mixed leachates, namely 1:2.5 and 1:5 dilutions completely (100%) inhibited the germination of seeds. At lower concentrations namely 1:10 and 1:20 this injurious effect was erased and 78.00 ± 8.40 and 79.00 ± 1.91 % seeds were germinated, respectively. It was observed that in combination, individual inhibitory effects of *Pueraria phaseoloides* (Table- 8.9) on seed germination was highly decreases at lower concentrations. On the other hand, the individual effects of *B. alata* (Table- 8.1), *Mitracarpus verticillatus* (Table- 8.6) and *S. indicus* (Table-8.11) were found to be suppressed at higher concentrations and to be inhibited at lower concentrations also.

The index of speed of germination under lower concentration of mixed leachates, namely 1:10 and 1:20, were calculated to 11.09 ± 0.84 and 11.00 ± 0.35 respectively.

Table 8.25. Effect of mixture of leachates of areal parts of *Borreria alata, Mitracarpus verticillatus & Pueraria phaseoloides* and whole plant of *Sporobolus indicus* on seed germination and seedling growth of *Streptocaulon sylvestre* Wight

PARAMETERS	CONCENTRATION OF SOLUTION				
	Control	1:2.5	1:5	1:10	1:20
Solution pH	7.00	4.70	4.88	7.50	7.64
Germination percentage	94.0 ± 2.58	Nil	Nil	78.00 ± 8.40	79.00 ± 1.91
Germination % inhibition or stimulation	00.00	-100.00	-100.00	-17.02	-15.96
Percentile of viability	100.00	00.00	00.00	82.98	84.04
Nonviable percentage	6.00	100.00	100.00	22.00	21.00
Index of speed of germination	18.88 ± 0.51	00.00	00.00	11.09 ± 0.84	11.00 ±0.35
Mean shoot length (cm) per seedling	2.66 ± 0.37	Nil	Nil	1.48 ± 0.30	1.78 ±0.26
Percentage of inhibition or stimulation of shoot length	00.00	-100.00	-100.00	-44.36	-33.08
Mean root length (cm) per seedling	2.14 ± 0.22	Nil	Nil	1.80 ± 0.38	1.64 ± 0.20
Percentage of inhibition or stimulation of root length	00.00	-100.00	-100.00	-15.89	-23.36
Mean total length (cm) per seedling	4.80 ± 0.39	Nil	Nil	3.28 ± 0.57	3.42 ± 0.41
Percentage of inhibition or stimulation of seedling length	00.00	-100.00	-100.00	-31.66	-28.75
Mean number of lateral roots	0.40	00.00	00.00	00.00	00.00
Shoot vigour index	250.04	00.00	00.00	115.44	140.62
Root vigour index	201.16	00.00	00.00	140.40	129.56
Seedling vigour index	451.20	00.00	00.00	255.84	270.18
Shoot / root ratio	1.24	Nil	Nil	0.82	1.08

+ / - signs indicates stimulatory / inhibitory effects of leachates.

These were more stimulatory as compared to the individual effects of *P. phaseoloides* and were inhibitory in comparison with the individual effects of *B. alata, M. verticillatus* and *S. indicus.*

The trend of early seedling development followed a similar pattern of response as of the same for germination. In mixture treatments, not only the lateral root initiation but also the growth of seedling was inhibited. Application of mixed leachates of 1:10 and 1:20 levels obtained shoot length of 1.48 ± 0.30 and 1.78 ± 0.26 cm, respectively, which were stimulatory in shoot length as compared with the individual effects of *P. phaseoloides* (Table- 8.9) and were inhibitory in comparison with the individual effect of *B. alata* (Table-8.1), *M. verticillatus* (Table-8.6) and *S. indicus* (Table-8.11). While the corresponding concentrations of mixed leachates showed root length of 1.80 ± 0.38 and 1.64 ± 0.20 cm, respectively, which were stimulatory as compared with the individual effects of *P. phaseoloides* and *B. alata* and were inhibitory in comparison with the individual effects of *M. verticillatus* and *S. indicus*. Moreover, seedling vigour index, shoot vigour index and root vigour index were lower in all viable concentrations of mixed leachates over the control.

The shoot : root ratio of seedling was very low at the concentrations of 1:10 and 1:20 (0.82 and 1.08 respectively) as compared to control (1.24) indicating more inhibition of shoot growth than root.

8.2.3.7. EFFECT OF MIXTURE OF LEACHATES OF *Desmodium triflorum, Sporobolus indicus, Mitracarpus verticillatus* AND *Saccharum spontaneum* ON SEED GERMINATION AND SEEDLING GROWTH OF *Streptocaulon sylvestre* WIGHT.

The effect of mixture of leachates of whole plants of *Desmodium triflorum* & *Sporobolus indicus* and areal parts of *Mitracarpus verticillatus* & *Saccharum spontaneum* on different parameters of seed germination and seedling growth of *Streptocaulon sylvestre* are recorded in Table- 8.26. The pH of the mixed leachates solution ranged between 5.68 and 8.12.

In the present investigation it was found that highest concentration of leachates mixture (1:2.5) showed strong (100%) inhibitory effect on seed germination and not a single seed was sprouted. At lower concentrations, namely 1:5, 1:10 and 1:20, this inhibitory effect was highly reduced and 69.00 ± 5.00, 78.00 ± 4.16 and 90.00 ± 2.58 % seeds, respectively, were germinated. This observation showed that in mixture, the individual effects of *Mitracarpus verticillatus* (Table- 8.6), *Saccharum spontaneum* (Table- 8.10) and *Sporobolus indicus* (Table-8.11) were suppressed at highest concentration (1.25) and were also remarkably changed in other concentrations. On the other hand, in combination, the individual inhibitory effect of *Desmodium triflorum* (Table-8.3) was not changed at highest concentration (1:2.5), but it increased

Table 8.26. Effect of mixture of leachates of whole plant of *Desmodium triflorum & Sporobolus indicus* and areal parts of *Mitracarpus verticillatus & Saccharum spontaneum* on seed germination and seedling growth of *Streptocaulon sylvestre* Wight

PARAMETERS	CONCENTRATION OF SOLUTION				
	Control	1:2.5	1:5	1:10	1:20
Solution pH	7.00	5.68	7.55	8.12	8.10
Germination percentage	95.0 ± 2.51	Nil	69.00 ± 5.00	78.00 ± 4.16	90.00 ± 2.58
Germination %inhibition or stimulation	00.00	-100.00	-27.37	-17.89	-5.26
Percentile of viability	100.00	00.00	72.63	82.10	94.73
Nonviable percentage	5.00	100.00	31.00	22.00	10.00
Index of speed of germination	19.00 ± 0.69	00.00	9.43 ± 0.30	12.16 ± 0.47	13.27 ± 0.38
Mean shoot length (cm) per seedling	2.70 ± 0.58	Nil	2.04 ± 0.56	2.50 ± 0.39	2.48 ± 0.29
Percentage of inhibition or stimulation of shoot length	00.00	-100.00	-24.44	-7.41	-8.15
Mean root length (cm) per seedling	1.56 ± 0.30	Nil	1.06 ± 0.27	2.14 ± 0.28	2.20 ± 0.28
Percentage of inhibition or stimulation of root length	00.00	-100.00	-32.05	+37.18	+41.02
Mean total length (cm) per seedling	4.26 ± 0.88	Nil	3.10 ± 0.68	4.64 ± 0.61	4.68 ± 0.55
Percentage of inhibition or stimulation of seedling length	00.00	-100.00	-27.23	+8.92	+9.86
Mean number of lateral roots	0.20	00.00	0.40	0.20	0.20
Shoot vigour index	256.50	00.00	140.76	195.00	223.20
Root vigour index	148.20	00.00	73.14	166.92	198.00
Seedling vigour index	404.70	00.00	213.90	361.92	421.20
Shoot / root ratio	1.73	Nil	1.92	1.17	1.13

'+' = stimulation ; '-' = inhibition.

the percentage of germination at all other concentrations (1:5, 1:10, 1:20).

In this investigation it was observed that the lower concentrations of mixed leachates, namely 1:5, 1:10 and 1:20, showed slow index of speed of germination of 9.43 ± 0.30, 12.16 ± 0.47 and 13.27 ± 0.38, respectively, against 19.00 ± 0.69 with control.

Application of mixture of leachates, namely 1:5, 1:10 and 1:20 dilutions achieved average shoot length of 2.04 ± 0.56, 2.50 ± 0.39 and 2.48 ± 0.29 cm and average root length of 1.06 ± 0.27, 2.14 ± 0.28 and 2.20 ± 0.28 cm, respectively. Similarly in the corresponding concentrations average seedling length were 3.10 ± 0.68, 4.64 ± 0.61 and 4.68 ± 0.55 cm, respectively. These shoot, root and seedling length were found to be longer than the shoot, root and seedling length found under the effect of the leachates of *D. triflorum* (Table- 8.3) and *S. spontaneum* (Table- 8.10) and found to be shorter than the shoot, root and seedling length obtained with the treatments of individual leachates of *M. verticillatus* (Table- 8.6) and *S. indicus* (Table- 8.11) at concentrations of 1:5 and 1:10 dilutions. Thus, the shoot, root and seedling growth with 1:5 and 1:10 dilutions of mixed leachates were recovered from the inhibitory effect of *D. triflorum* and *S. spontaneum* when applied in combination with the leachates of *M. verticillatus* and *S. indicus.*

In addition, lateral roots were also initiated at all viable concentrations. Moreover, as compared to control, shoot vigour index was lower at all concentrations of mixed leachates. Rather root vigour index was higher at the concentrations of 1:10 & 1:20, although it was lower at the concentration of 1:5.

At 1:10 and 1:20 dilutions, the shoot : root ratio of seedling was lower (1.17 and 1.13, respectively) than that of control (1.73) expressed the slow growth of shoot system than root but at the concentration of 1:5 the shoot : root ratio was increased (1.92), indicating retardation of root growth as compared to shoot.

From the observations made with three series of allelopathic experiments with the leachates and extracts of different species individually, and the leachates of different species in combination, it is seen that none of the leachates or extracts or mixed solutions at highest concentration (1:2.5) showed promotory effect instead, high to complete inhibitory effects were expressed clearly on the germination of seeds and subsequent seedling growth of *Streptocaulon sylvestre.* However the leachates or extracts of *Borreria alata,* either individually or in combination with other species had no major effect on seed germination. Interestingly, its allelopathic effect was noticed in seedling elongation, specially on the elongation of root. It may

be inferred, therefore, that *Borreria alata* might be competing with *Streptocaulon sylvestre* to some extent by restraining its post-germinational aspects, rather than inhibiting at the stage of germination.

It is also noteworthy that leachates or extracts of *Cymbopogon pendulus* and *Elephantopus scaber* at lower concentrations showed better germination and stimulated seedling growth of *Streptocaulon sylvestre.* These data reflect that inhibitory or stimulatory effect of a given plant leachates or extracts affects differentially under different concentrations. This agrees with the views of Rice (1984) who stated " apparently most, if not all, organic compounds that are inhibitory at same concentrations are stimulatory to the same process in very small concentrations". The results suggest that the growth inhibitory compounds due to auto-toxic principles contained in the plant tissue are concentration rate dependent. At lower concentrations, with some species, these compounds did not inhibit the germination or seedling growth or rather tended to stimulate, whereas at higher concentrations they inhibited the germination and seedling growth of *Streptocaulon sylvestre.*

Similarly, *Mitracarpus verticillatus, Sporobolus indicus, Vernonia cinerea, Mnesithea laevis, Prunella vulgaris* and *Rungia pectinata* at lower concentrations stimulated seedling growth of *S. sylvestre* and none of them at highest concentration showed promotory effect. This is in confirmity with the observation made by Chatterji (1975) where aqueous extracts of *Crotalaria medicagenea* in lower concentration stimulated the growth of hypocotyl and radicle of the seedling of *Calligonum polygonoides* while the highest concentration was inhibitory.

The observation showed that *Pueraria phaseoloides* was a highly toxic plant which strongly inhibited not only the germination of seeds but also the seedling growth of *Streptocaulon sylvestre* with all the dilutions of its leachates and extracts under use. It indicates the presence of a potent germination and growth retarding factor of allelopathic implication for *Streptocaulon sylvestre* in the commonly associated species. So an intensive study of the plant communities in relation to *Pueraria phaseoloides* might be of great practical value for understanding the allelochemic interactions.

The results also showed that *Desmodium triflorum, Carex indica, Lindernia crustacea* and *Saccharum spontaneum* were found to be highly inhibitory to the germination and seedling growth of *Streptocaulon sylvestre*. It may be inferred that these plants not only compete with *Streptocaulon* sylvestre but also interact quite effectively due to their allelopathic potentialities.

Furthermore, in mixed leachates, *Cymbopogon pendulus, Mitracarpus verticillatus* and *Sporobolus indicus* reduced the inhibitory effect of *Pueraria phaseoloides* and *Desmodium triflorum* on seed germination and seedling growth of *Streptocaulon syvestre*. It may be inferred that reversion of inhibitory effect of *Pueraria phaseoloides, Desmodium triflorum* and other associates on germination and seedling growth of *Streptocaulon sylvestre* is possible with the addition of the leachates / extracts from some other common associate plants.

However, it was observed that the rate of inhibition of extract solutions were more than respective leachate solutions. It suggests that some compounds of plants do not leach out and / or the compounds in the test solutions are higher in extracts than in the leachates. Since the effect of leachates or extracts were variable with the variation of concentration of solutions, the compound/s responsible for inhibition or stimulation are supposed to be water soluble in nature. It is likely that these compounds leach out from the plants during the monsoon season or during decomposition of residues and then get absorbed into the soil. Thereafter the moisture in the soil dilute the released compounds to cause auto toxicity in field conditions. Schreiner and Reed (1908) reported that all the allelopathics are water soluble compounds, mostly phenolic in nature. Phenolic compounds may be in-effective, inhibitory or stimulatory in their biological activities (Kefeli and Kadyrov, 1971).

It is, now, concluded from the above findings that allelochemicals present in associated plants get released into the soil through the residue incorporation or leach out from the plants, are inhibitory or stimulatory to seed germination, growth and development of *Streptocaulon sylvestre.* Concentration of released allelochemicals from the associated plants is also a limiting factor in controlling their effects. Further research on allelopathic effects of these associate plants is essential to identify the allelochemicals and the effective use of those chemicals for the conservation of critically endangered and endemic plant like *Streptocaulon sylvestre* Wight.