DISCUSSION
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Based on information scattered in the literature (Hillman, 1961) and preliminary observations made (Shukla, Pandey and Shukla, 1973; Shukla and Pandey, 1976; 1979) perimeters of study set up as described earlier for present investigation, bore fruits and revealed interesting results. They provided a new dimension of importance to lemnoids. Present investigation has brought to knowledge facts of both academic and applied significance. The utility of duckweeds in obtaining extracts to be employed in agriculture has further multiplied their importance. A correlative discussion of observations made during present investigation and facts recorded elsewhere in the literature would be provided a conceptual synthesis of subject matter.

The natural history and geographical distribution of duckweeds is suggestive of their global occurrence. About half of the total number of species of the family Lemnaceae are basically tropical or sub-tropical but rest of them are distinctly temperate. Spirodea polyrhiza, Lemna gibba, L. minor
and *L. perpusilla* appear world wide in distribution. *L. trisulca* is confined to only cold climatic areas. Bulk of other *Spirodellas, Wolffiias* and *Wolffiellas* are primarily Australasian, American, African or Asiatic tropical species (Hegelmaier, 1868). There are also reports of other lemnoid species from South America (Koch, 1932) and Australasian species from Missouri (Saeger, 1934). The known cosmopolitan lemnoids are conspicuously absent in certain localities. The aforesaid distribution is suggestive of the fact that further investigations might show either influx of lemnoids in certain localities as a result of their migration from elsewhere or their disappearance. Survey reports on estimated trends of duckweed infestations are also suggestive of their increase, decrease or constant growth in India (Varshney and Singh, 1973). Such observations have also remained tangible during present investigations and out of various cosmopolitan lemnoids referred to earlier, *Lemna paucicostata, Spirodella polyrhiza* and *Wolffia arrhiza* only could be recorded from habitats of Banda. This emphasises that perhaps dynamic features of habitats are closely linked with duckweed infestations.

General topics on lemnoid growth, distribution and details of nature of its habitats have met a cursory treatment in the literature (Guppy, 1894; Hicks, 1937; Rao, 1953;
Luther, 1951). The topic has been dealt in some detail by Landolt (1957), Arber (1920), and Shukla and Pandey (1979). The broader concepts are based on information on lemnoids like *Lemna minor*, *L. valdiviana*, *L. trisulca*, *L. gibba*, *L. perpusilla*, *Wolffia punctata* and *Wolffiella lingulata*.

There are also casual reports about *S. polyrhiza's* response to temperature. As referred to earlier, growth of lemnoids in Banda has been obtained in slightly moving or stagnant waters of small ponds, ditches, drainage channels or sewer outlets rich in organic matter or they may continue to grow out of water on wet mud (McCley, 1974). The range of pH of water between 6.5 to 10.5, a varied sunlight to dense shade and temperature of 20 to 30°C supports duckweeds in Banda. Habitats and ecological conditions prevailing in Banda supporting duckweed growth fit in general within broad ambit of variance of environmental perimeters prevalent in lemnoid infested areas elsewhere but it is interesting to note that out of 20-30 lemnoid species (Hillman, 1961a) only three of them *S. polyrhiza*, *L. paucicostata* and *W. arrhiza* could be recorded from Banda. Notably it becomes apparent that light intensities, temperature range and nutritional backdrop of aquatic environment may only be conducive to growth of hitherto, referred species or the area still awaits invasion and
migration of other species from other localities, elsewhere.

During present study three lemnoid species have exhibited profuse turion formation and cloning in nature. The principal mode of reproduction happened to be cloning but *L. paucicostata* showed rare occurrence of both flowering and fruiting. However, other two lemnoids (*S. polyrhiza* and *W. arrhiza*) showed total absence of flowering. A perusal of literature shows that certain species, particularly *L. gibba* and *L. perpusilla* are frequently found to flower (Landolt, 1957). These two species have been unequivocally used as experimental material to study *in vitro* induction of flowering (Kandeler, 1955; Hillman, 1958). Other investigators have also induced flowering in *L. perpusilla*, *Wolffia microscopica*, *W. papulifera* and *Wolfiella* sp. (Mason, 1938; Maheshwari and Chauhan, 1963; Maheshwari and Venkataraman, 1966; Maheshwari and Seth, 1966; Maheshwari and Gupta, 1967; Gupta and Maheshwari, 1970a; 1970b etc.).

Flowering in other species notably *S. polyrhiza* and *W. arrhiza* is rare. Absence of flowering in *W. arrhiza* may well, therefore, be anticipated as observed during present investigation. Observations on absence of flowering in *W. arrhiza* are in conformity with earlier report of Bhambie

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Aquatic environments supporting growth of lemnoïds are beset with typical conditions due to interrelated interaction of duckweed infestation and environment. Luxurient growth of lemnoïds virtually modified environment. Low oxygen content interlinked with high organic constituent, especially, organic nitrogen stimulate conditions ideal for growth of algae particularly Cyanophyceae in association with lemnoïds (Stephanova, 1928; Rao; 1953; Shukla and Pandey, 1979).

Various investigators have used several media for culture of lemnoïds. Among common media used M-sucrose medium (Oota, 1966; 1969; Pieterse, Bhalla and Sabharwal, 1970a); Hutner's medium (Pieterse, Bhalla and Sabharwal, 1970b); medium containing sucrose, casein hydrolysate, tryptophan and kinetin (Rombach, 1971); Hoagland's modified medium (Gorham, 1950); and Pirson and Siedel's medium may be cited. The best medium reported for maintaining vigorous growth over long periods of time in Hutner's medium. The question of auximone requirements and necessity of essential organic growth factors occupied frequent references in the literature (Bottomley, 1920a; 1920b; Mockeridge, 1924). These early works suggested that perhaps extracts of peats, leaf
mold, soil or manure are needed for growth and multiplication of lemnoids but later studies conclusively suggested that organic materials were not necessarily required (Ashby, 1929; Clark and Roller, 1924; 1931; Saeger, 1925; 1930; Wolfe, 1926). It was also demonstrated that *Lemna* grown in aseptic inorganic medium even formed larger amounts of vitamins A, B and C (Clark, Thomas and Frahm, 1938).

Despite these facts bulk of media used elsewhere contained organic compounds or metal chelators like EDTA. Reports that purely inorganic media sufficiently meet nutritional requirements led to study effects of certain pure inorganic media on growth of duckweeds during present investigations.

Major micro-elemental requirements of lemnoids constitute iron, manganese, molybdenum, boron, zinc, copper and gallium though necessity of the last three is not well established. Minute quantities of chloride also appear to be needed for growth of lemnoids (Hillman, 1961a).

Based on these facts the medium selected to undertake detailed experimental work contained K-2mg., Ca-4mg., Mg-2mg., P-2mg., N-6mg., Fe-5.6 ppm. Mn-0.23 ppm. Cu-0.032ppm, Zn-0.032ppm, Mo-0.025 ppm, B-0.185 ppm, Co-0.003 ppm and Ni-0.003 ppm (Strength per litre). This
medium exhibited marked improved growth and multiplication of *S. polyrhiza*. Known symptoms of deficiencies of macro and micro-nutrients described elsewhere (White, 1936; 1938; 1939; White and Templeman, 1937; Steinberg, 1946; Allison, Love, Pinck and Gaddy, 1948; Pirson and Gollner, 1953b; Bierhuizen, 1954; Martin, 1955; Reid and Bieleski, 1970) could not be observed during usage of hitherto, referred inorganic medium. This has further thrown light on auximone requirements of plants and substantiated the findings of Wolfe (1926), Ashby (1929) and Clark (1932) that organic substances are not required for prolonged growth of lemnoids (*L. paucicostata, S. polyrhiza* and *W. arrhiza*). The fact is of considerable significance for developing *in vitro* cultural technique to grow lemnoids under room temperature in tropical countries where addition of organic substances like sugars, coconut milk etc. is likely to set in fermentation of medium thereby obstructing aseptic growth of lemnoids.

Existence of growth-promoting substances in various plants has been known and their extraction for utilization in agriculture has also been emphasized in the literature. In addition to fungi and bacteria a number of higher plants have been reported to contain gibberellins (Katznelson, Sirosis and Cole, 1962; Brian, Hemming and Lowe, 1964; Maheshwari
and Bhatia, 1966; Jones and Lang, 1968; Pronano and Greene, 1968; Hayashi, Natto, Buckovac and Sell, 1968; Iwahori, Weaver and Pool, 1968). Gibberellins have been reported from some marine algae (Mowat, 1963; 1964; 1965; Jennings and McComb, 1967). Likewise, gibberellin-like substances have been reported in extracts of *Phormidium foveolarum* (Gupta and Shukla, 1967; Gupta and Agarwal, 1973) and developing watermelon seeds (Bhalla, 1971). Growth promoting substances have also reported in root extracts of water hyacinth (Sircar and Kundu, 1960). There is evidence of endogenous gibberellins in floating plants and turions of *Wolffiella floribanda* (Pieterse, Bhalla and Sabharwal, 1971).

Exhaustive literature on utilization of algal extracts of *Phormidium foveolarum* in agriculture of rice (Gupta and Shukla, 1964; 1967; 1969; Shukla and Gupta, 1967; Shukla, 1968; 1975a); wheat (Kushwaha and Gupta, 1970a; 1970b; Shukla, 1975b), *Vigna catzang* (Gupta and Gupta, 1970; 1972; 1973) and *Phaseolus aureus* (Gupta and Gupta, 1972) is available. Shukla (1983) emphasized utilization of algal extracts to boost rice growth and productivity. Likewise, stimulation in vegetative growth and yield of rice following treatments with water hyacinth extracts has also been reported.
(Sircar, 1963). Influence of *L. paucicostata* manure and spraying with its extracts on *Hordeum vulgare* was explored by Pandey (1979) and the study revealed significant effects on fresh and dry matter production, yield, ascorbic acid, catalase, chlorophyll and epidermal structure of plants.

Observations on juvenile seedling growth of wheat plants show that out of various concentrations (1, 2 and 5 percent) of extracts tried, 1 percent extract exhibits all-round maximum beneficial growth. Length of primary root, number of secondary roots and length of plumule exhibit marked increase with 1 percent extracts (except 6 hrs soaking with water extract where 2 percent extract is more effective). Improved seedling growth is proven with prospects of better crop.

There is uniform allround, maximum effectiveness of extracts in concentrations of 1 percent ether and 2 percent water in 6 hrs, 1 percent ether and 1 percent water in 12 hrs and 1 percent ether and 1 percent water extract in 24 hrs of *S. polyrhiza*. Evidently, ether extracts of *S. polyrhiza* are more effective than water extracts.

Increases under 6 hrs treatments in length of primary root, number of secondary roots and length of plumule
increased 23.76, 55.76 and 85.74 percent with 1 percent ether extract respectively. However, increases in length of primary root, number of secondary roots and length of plumule were found to be 34.61, 64.09 and 89.67 percent with 2 percent water extract respectively during present investigation on expiry of experiments after 96 hrs. Increase under 12 hrs treatments in length of primary root, number of secondary roots and length of plumule increased 29.17, 40.93 and 75.12 percent with 1 percent ether extract respectively. Increases in length of primary root, number of secondary roots and length of plumule were found to be 26.93, 55.48 and 67.35 percent with 1 percent water extract respectively during present investigation on expiry of experiments after 96 hrs. Increase under 24 hrs treatments in length of primary root, number of secondary roots and length of plumule increased 46.93, 42.95 and 91.90 percent with 1 percent ether extract respectively, but increases in length of primary root, number of secondary roots and length of plumule were found to be 39.79, 60.64 and 96.94 percent with 1 percent water extract respectively.

Observations emphasize that in general effects of 12 hrs treatment with both ether and water extracts is better as compared to 6 and 24 hrs treatments. Stimulatory effect of
treatments gradually increases from 6 to 12 hrs treatments and declines with longer pre-soaking seed treatment period form 12 to 24 hrs.

Influence of *S. polyrhiza* extracts on mature wheat plant growth and yield have shown promising results. One percent ether extract under 6, 12 and 24 hrs pre-soaking exercised increased in height of plants, number of tillers, number of leaves, length of leaves and breadth of leaves. Treated plants were more livelier and intensely green. Increased tillering is of paramount importance as it is interlinked with production of ears and consequently the yield.

Influence of 6 hrs treatments with 1 percent ether extracts of *S. polyrhiza* showed increases of 8.40, 39.65, 38.37, 18.92 and 27.01 percent over control on height of plants, number of tillers, number of leaves, length of leaves and breadth of leaves respectively. An increase of 6.30, 20.27, 21.22, 8.74 and 10.29 percent under effect of treatments with 2 percent water extract was observed on height of plants, number of tillers, number of leaves, length of leaves and breadth of leaves respectively. Influence of 12 hrs treatments with 1 percent ether extract of *S. polyrhiza* showed increases of 8.62, 48.65, 50.47, 26.32 and 27.56 percent over control on height of plants, number of tillers, number of leaves,
length of leaves and breadth of leaves respectively. An increase of 5.90, 28.07, 18.14, 8.79 and 13.14 percent under effect of treatments with 1 percent water extract was observed on height of plants, number of tillers, number of leaves, length of leaves and breadth of leaves respectively. Likewise 24 hrs treatments with 1 percent ether extract of *S. polyrhiza* showed increases of 6.62, 32.44, 36.67, 9.81 and 28.48 percent over control on height of plants, number of tillers, number of leaves, length of leaves and breadth of leaves respectively. An increase of 5.05, 20.69, 19.22, 7.22 and 4.30 percent under effect of treatments with 1 percent water extract was observed on height of plants, number of tillers, number of leaves, length of leaves and breadth of leaves respectively.

Results on increase with 6, 12 and 24 hrs treatments show that in case of ether extracts there is a gradual increase in effect with increase in pre-soaking period of seeds with 6 and 12 hrs and declines with 24 hrs. However, in case of water extract height of plants, number of tillers, number of leaves, length of leaves, and breadth of leaves in 12 hrs treatment was found to be multiplied to the maximum extent.

Data on crop productivity shows that dry weight of straw per plant, dry weight of ears per plant, dry weight of single ear, dry weight of 1000 seeds, percentage ear emergence per
day and time required for ear emergence is higher in plants treated with 1 percent ether extract in 6, 12 and 24 hrs pre-soaking.

Percentage increases with 1 percent ether extract and 6 hrs. treatment in dry weight of straw per plant, dry weight of ears per plant, dry weight of single ear, dry weight of 1000 seeds, percentage ear emergence per day and time required for ear emergence was found to be 146.54, 120.21, 102.21, 25.78, 83.66 and 14.63 percent respectively. However, 2 percent water extract under 6 hrs treatment increased 62.96, 68.88, 61.88, 16.47, 54.88 and 4.88 percent in dry weight of straw per plant, dry weight of ears per plant, dry weight of single ear, dry weight of 1000 seeds, percentage ear emergence per day and time required for ear emergence respectively. Percentage increases with 1 percent ether extract and 12 hrs treatment in dry weight of straw per plant, dry weight of ears per plant, dry weight of single ear, dry weight of 1000 seeds, percentage ear emergence per day and time required for ear emergence was found to be 195.58, 145.53, 71.55, 22.94, 32.40 and 13.92 percent respectively. However, 1 percent water extract under 12 hrs treatment increased 59.61, 120.94, 47.84, 16.78, 16.94 and 3.80 percent in dry weight of straw per plant, dry weight of ears per plant, dry
weight of single ear, dry weight of 1000 seeds, percentage ear emergence per day and time required for ear emergence respectively. Percentage increases with 1 percent ether extract and 24 hrs treatment in dry weight of straw per plant, dry weight of ears per plant, dry weight of single ear, dry weight of 1000 seeds, percentage ear emergence per day and time required for ear emergence was found to be 143.17, 83.76, 74.25, 25.86, 73.40 and 13.95 percent respectively. One percent water extract under 24 hrs treatment increased 65.30, 50.02, 52.12, 12.20, 48.85 and 5.81 percent in dry weight of straw per plant, dry weight of ears per plant, dry weight of single ear, dry weight of 1000 seeds, percentage ear emergence per day and time required for ear emergence respectively.

Results obtained emphasized that increase in weight of single ear is proportional to weight of seeds produced. It may be suggested that although seeds and ears produced in treated plants are heavier, the final yield depends on the number of ears produced per plant to a very large extent and appears to be controlled and coordinated partly by number of tillers developed per plant.

Results indicate that vegetative dry matter production and yields in ether and water extracts were stimulated with
increase in pre-soaking period of seeds with *S. polyrhiza* extracts and maximum yields were observed with 12 hrs treatments. The data is suggestive of the fact that weight of single ear and 1000 seeds are not crucial for yields but number of ears per plant produced controls the final outcome of yields.

Judging critically while response of various treatments on multiple parameters of seedling (length of primary root, number of secondary roots and length of plumule) and mature vegetative growth (height of plants, number of tillers, number of leaves, length of leaves and breadth of leaves) may show variance it is finally vegetative dry matter production and yield which matters as an index to gauge effectiveness of treatments. On the basis of this it may be said that the vegetative growth and yield is multiplied to the maximum extent with 1 percent ether extract under 12 hrs pre-soaking seed treatment. Application of 1 percent ether extract of *S. polyrhiza* and 12 hrs pre-soaking seed treatment is therefore, recommended for adoption by agriculturists.

When multiple effects of *S. polyrhiza* extracts containing growth promoting substances on wheat plants are examined it becomes evident that concentration, kind of extract, nature of treatment and environmental conditions all play important
role in the final outcome of treatment.

Observations emphasize that 1 percent ether extract under pre-soaking seed treatments of 12 hrs appears to be needed to stimulate seedling growth, vegetative growth of mature plants and grain yield. Results emphasize that for sustained effects of treatments longer pre-soaking seed treatments yield better results. Sufficiency of 12 hrs treatments in case of ether extracts emphasizes better extraction of growth substances with ether than water. Extraction of plant material for pre-soaking seed treatment was made in water and ether extract suspended in ether. It was observed that stimulatory effect of \textit{S. polyrhiza} extracts depends upon nature of extract and soaking period. Conclusively, effect of 12 hrs pre-soaking seed treatment with 1 percent ether extract suspended in water of \textit{S. polyrhiza} exercised maximum stimulation in growth, development and yield of wheat plants.

The mineral matter in flour is not quantitatively large but has considerable impact on quality and behaviour of flour. Percentage of mineral matter is indicator of grade and quality of the flour. It is well known that elemental composition in wheat is dependent on nature of soil (Beeson, 1941; Booth, Carter, Jones and Moran, 1941). A good deal of variance in mineral matter of Indian wheats has been observed. Availability
of larger quantities of nitrogen and phosphatic fertilizers to wheat resulted in higher protein and phosphorus content in wheat grains (Bains, 1949). There appears migration of nitrogen, phosphorus and potash during different stages of crop.

In the light of significance of mineral constituents of wheat grains changes in nitrogen, phosphorus and potash are of pivotal importance in controlling quality of wheat flour. The nitrogen and protein contents go hand in hand.

The percentage of protein under influence of 1 percent ether extract 6 hrs treatment in root, stem, leaf and wheat grains increased 8.96, 24.89, 55.69 and 7.44 percent respectively. However, an increase of 3.30, 8.44, 45.15 and 4.61 percent were observed with 2 percent water extract in case of root, stem, leaf and grains respectively. The percentage of protein under influence of 1 percent ether extract 12 hrs. treatment in root, stem, leaf and wheat grains increased 17.78, 31.65, 60.94 and 10.45 percent respectively. But an increase of 33.33, 24.05, 51.17 and 8.18 percent were observed with 1 percent water extract in case of root, stem, leaf and grain respectively. The percentage of protein under influence of 1 percent ether extract 24 hrs. treatment in root, stem, leaf and grains increased 9.22, 20.75, 54.11 and 7.51
percent respectively. An increase of 2.91, 11.79, 32.47 3.76 percent were observed with 1 percent water extract in case of root, stem, leaf and grains respectively.

The percentage of nitrogen under influence of 1 percent ether extract 6 hrs treatment in root, stem, leaf and wheat grains increased 8.82, 25.00, 55.26 and 7.44 percent respectively. However, an increase of 2.94, 8.33, 44.74 and 4.65 percent were observed with 2 percent water extract in case of root, stem, leaf and grains respectively. The percentage of nitrogen under influence of 1 percent ether extract 12 hrs treatment in root, stem, leaf and wheat grains increased 44.44, 31.58, 60.98 and 11.87 percent respectively. However, an increase of 33.33, 23.68, 51.22 and 8.22 percent was observed with 1 percent water extract in case of root, stem, leaf and grains respectively. The percentage of nitrogen under influence of 1 percent ether extract 24 hrs treatment in root, stem, leaf and grains increased 9.09, 20.59, 54.05, 7.51 percent respectively. However, an increase of 3.03, 1.18, 32.43, 3.76 percent were observed with 1 percent water extract in case of root, stem, leaf and grains respectively.

The percentage of phosphorus under influence of 1 percent ether extract 6 hrs treatment in root, stem, leaf and wheat grains increased 5.56, 1.55, 3.07 and 18.39 percent
respectively. Increase of 3.57, 0.78, 0.77 and 4.67 percent was observed with 2 percent water extract in case of root, stem, leaf and grains respectively. The percentage of phosphorus under influence of 1 percent ether extract 12 hrs treatment in root, stem, leaf and wheat grains increased 5.40, 5.28, 4.51 and 11.10 percent respectively but increases of 4.25, 3.39, 3.01 and 9.03 percent were observed with 1 percent water extract in case of root, stem, leaf and grains respectively. The percentage of phosphorus under influence of 1 percent ether extract 24 hrs. treatment in root, stem, leaf and wheat grains increased 5.18, 1.57, 2.32 and 7.65 percent respectively. However, an increase of 2.79, 0.78, 1.16 and 5.05 percent were observed with 1 percent water extract in case of root, stem, leaf and grains respectively.

The percentage of potash under influence of 1 percent ether extract 6 hrs treatment in root, stem, leaf and wheat grains increased 7.69, 5.59, 6.33 and 15.25 percent respectively. Observed increase of 3.20, 0.62, 3.16 and 6.78 percent with 2 percent water extract in case of root, stem, leaf and grains respectively was recorded. The percentage of potash under influence of 1 percent ether extract 12 hrs treatment in root, stem, leaf and wheat grains multiplied 6.88, 5.29, 9.04 and 13.04 percent respectively. However, an increase of 5.63,
2.94, 6.02 and 7.25 percent with 1 percent water extract of *S. polyrhiza* plants in case of root, stem, leaf and grains respectively was observed.

The percentage of potash under influence of 1 percent ether extract 24 hrs treatment in root, stem, leaf and wheat grains increased 7.84, 3.14, 5.10 and 12.07 percent respectively and an increase of 3.27, 1.26, 1.91 and 1.57 percent with 1 percent water extract in case of root, stem, leaf and grains respectively was recorded.

A perusal of protein increase may be viewed in the light of the fact that stem and leaf form straw used for feeding cattle while grain is meant for human consumption. Observed increases in protein contents of both straw and grains are therefore of significance.

During present investigation *S. polyrhiza* extracts have exercised increase in protein, nitrogen, phosphorus and potash constituents of the grain which are of considerable significance towards edible value and roughage quality of wheat. Observed increases appear to be at the expense of other constituents of lesser commercial significance.

Results of present investigation show that there is a marked influence of *S. polyrhiza* extracts on growth,
development and yield of wheat plants. The results are in agreement with Sircar (1963) who has similarly reported stimulated growth of rice following treatments with root extract of water hyacinth; barley with *Lemna paucicostata* extracts (Pandey, 1979)' and wheat with *Pistia stratiotes* extracts (Maurya, 1983). Results are suggestive of the fact that application of *S. polyrhiza* extracts not only results in more protein rich wheat productivity but also induces larger mineral constituents thereby improving the quality of flour. It would be of interest to compare straw and grain yield of wheats under applications of *Pistia stratiotes* extracts described elsewhere (Maurya, 1983) with relative promotion in productivity implemented by *S. polyrhiza* extracts during present investigation. While *P. stratiotes* extracts stimulated 85.5 percent in straw and 38.0 percent in grain yield. *S. polyrhiza* extracts provided a much higher boost to productivity, to the extent of 195.54 and 145.53 percent in straw and grain yield respectively. Conclusively, effectiveness and utility of *S. polyrhiza* is higher than *P. stratiotes* extracts for adoption in practical agriculture of wheat.

The physiological peculiarities of plants in general and rice in particular (Sircar, 1958) are known to possess different auxin levels at various sites which appears to control growth
and developmental pattern in various parts of the plants. A high IAA content of endosperm regulates germination and seedling growth in rice (Sircar and Das, 1954). Sircar and Dutta Ray (1962) realised the significance of IAA in nitrogen metabolism of germinating seeds. Internal IAA level has also been presumed to be linked with subsequent plant growth and tillering (Sircar and Parija, 1949; Sircar and Das, 1954). Increase in IAA level of stamens and carpels till anthesis appears to result in reproductive growth (Sircar and Chakravarty, 1957). Thus, various physiological processes of rice are regulated by IAA in various organs. It has been suggested that auxin level in rice occurs in two parts. A bulk of auxin remains in inactive form in vacuoles and active auxin part below suboptimal concentration is found at the sites of growth to bring about stimulation. Exogenous supplies of other growth regulators, sets in a competition between native IAA and exogenous growth regulators which displaces native auxin from its natural site of action leading to higher concentration of free auxin to exercise stimulated growth (Sircar, 1958).

It may suggested that a similar auxin level controlled mechanism as referred to earlier in case of rice may be operative in wheat under exogenous supply of growth substances present in *S. polyrhiza* extracts. The application of *S.*
polyrhiza extracts containing growth substances suggest complex relationship between internal auxin level and external application of growth substances present in extracts. Changed growth, yield, metabolism and morpho-anatomical peculiarities are results of their action intermesh yielding fine fabric of stimulated growth and yield.

A perusal of results on the effect of S. polyrhiza extracts on diameter of xylem and phloem tissues and size of tracheids shows a marked alteration. The xylem-phloem and ground tissue ratio is concomittantly effected. The increase in xylem-phloem tissue appears to be at the expense of cortex and ground tissue.

A comparison of results of 6, 12 and 24 hrs pre-soaking seed treatment on anatomy shows significant changes. Twelve hours treatment is effective to the maximum extent. Influence of ether extract in 6, 12 and 24 hrs are more pronounced.

Results on anatomy of root show that 6, 12 and 24 hrs. treatments with ether extract of S. polyrhiza uniformly stimulate formation of xylem and phloem tissue coupled with increase in the size of tracheids.

There is a uniform alround maximum effectiveness of 1 percent ether and 2 percent water (6 hrs), 1 percent ether
and 1 percent water (12 and 24 hrs) extracts of *S. polyrhiza* examined. Evidently, ether extracts of *S. polyrhiza* are more effective than water extracts. Increase in diameter of root, diameter of stele, diameter of vascular bundles, diameter of metaxylem, number of protoxylem per microscopic field and number of root hair per microscopic field to the extent of 8.81, 17.65, 11.19, 11.15, 18.24 and 5.66; 13.57, 15.33, 10.44, 13.39, 13.46 and 13.05; 11.07, 14.26, 10.38, 16.47, 19.90 and 6.98 percent over control in 6, 12 and 24 hrs treatments respectively in roots with ether extracts have been recorded. Diameter of root, diameter of stele, diameter of vascular bundle, diameter of metaxylem, number of protoxylem per microscopic field, number of root hair per microscopic field increased 2.93, 4.72, 8.06, 5.56, 3.62 and 3.74; 7.04, 9.13, 7.10, 2.47, 3.48 and 6.05; 7.36, 5.20, 6.62, 8.39, 9.20 and 2.37 percent with water extract under 6, 12 and 24 hrs treatments respectively.

Anatomy of stem is also markedly influenced by *S. polyrhiza* extracts. Twelve hrs treatment with ether extract exercises maximum increase in diameter of xylem tissue, diameter of phloem tissue, diameter of stem, diameter of metaxylem, diameter of protoxylem and number of vascular bundles in stem.
Diameter of xylem tissue, diameter of phloem tissue, diameter of stem, diameter of metaxylem, diameter of protoxylem and number of vascular bundles increased 23.02, 19.88, 13.86, 27.97, 7.66 and 39.90; 24.00, 23.49, 11.55, 16.80, 8.65 and 27.87; 26.14, 31.93, 39.35, 33.52, 17.36 and 40.71 percent with ether extract under 6, 12 and 24 hrs treatments respectively in stem. Diameter of xylem tissue, diameter of phloem tissue, diameter of stem, diameter of metaxylem, diameter of protoxylem and number of vascular bundles increased 11.35, 5.50, 7.80, 22.38, 3.70 and 22.72; 8.97, 7.90, 10.99, 11.81, 2.68 and 18.06; 16.48, 16.32, 34.81, 18.29 14.11 and 19.56 percent with water extract under 6, 12 and 24 hrs treatments respectively.

The number of tracheary elements found in the tension wood induced by DNP in some seedlings are either equivalent or in others slightly reduced, relative to the number of tracheary elements present in xylem formed before treatment. In the *Acer rubrum* system (Morey, 1968a; 1968b) it is probable that the relative frequency at which tracheary elements are initiated from the fusiform initials related to the level of auxin in the cambial initiation zone. This implies that the level of auxin in the system below the DNP treatment site where tracheary elements are initiated from the dividing
initials or adjacent cambial derivatives is largely unaffected by treatment with DNP. It seems inconsistent, on the other hand that the capacity of DNP to induce the formation of tension wood in the same region of the stem is explained in terms of developmental response to auxin deficiency. However, the cambial derivatives undergoing secondary wall development, namely the xylem elements in the wall thickening phase of development are segregated from the cambial initials by more or less arbitrary zone of cells in which the walls are expanding by surface growth (Morey and Cronshaw, 1966). In this regard DNP may be more effective in lowering the auxin level in the centripetal zone of the stem than in the peripheral peristematic region.

This synoptical background about development of tracheids is clearly indicative of the fact that development of xylem is linked with auxin level in both root and stem. Auxin deficiency stimulates development of xylem. Exogenous supplies of certain growth substances which blocked polar transport of auxins create deficiency of auxin in areas just above the region of blockade (Cronshaw and Morey, 1965). During present investigation exogenous supply of growth substances in extracts of S. polyrhiza extracts provided through pre-soaking seed treatment appear to set in some kind of
compeition with the endogenous auxin levels and displace auxin through polar transport to the extremities of root and stem to initiate their apical growth, and in the process create conditions of auxin deficiency in the older regions of two organs, thereby stimulating development of xylem in the root and shoot. This may explain the increased formation of xylem, phloem and diameter of tracheids observed during present investigation.

Number of epidermal cells per microscopic field, number of stomata per microscopic field, length of epidermal cell, breadth of epidermal cell, perimeter of stomatal pore, length of guard cells and breadth of guard cells increased: 14.00, 60.73, 16.02, 15.18, 16.71, 10.90 and 42.40; 9.80, 46.52, 46.21, 19.50, 24.02, 11.01 and 25.59; 6.99, 75.58, 9.61, 12.08, 13.28, 11.59 and 40.58 percent with ether extract under 6, 12 and 24 hrs treatments respectively on upper epidermis of leaves.

Number of epidermal cells per microscopic field, number of stomata per microscopic field, length of epidermal cell, breadth of epidermal cell, perimeter of stomatal pore, length of guard cells and breadth of guard cells increased: 4.75, 28.86, 5.34, 4.56, 10.05, 6.39 and 22.24; 4.78, 21.66, 31.53,
11.78, 12.49, 5.83 and 12.82; 3.54, 70.50, 7.13, 3.59, 3.90, 4.19 and 17.69 percent with water extract under 6, 12 and 24 hrs treatments respectively on upper epidermis of leaves.

Number of epidermal cells per microscopic field, number of stomata per microscopic field, length of epidermal cell, breadth of epidermal cell, perimeter of stomatal pore, length of guard cells and breadth of guard cells increased 9.16, 21.45, 11.39, 18.59, 3.09, 5.24 and 25.68; 10.66, 47.52, 12.77, 8.19, 15.35, 7.90 and 30.23; 10.34, 79.66, 12.38, 15.87, 4.38, 2.78 and 22.38 percent with ether extract under 6, 12 and 24 hrs treatment respectively on lower epidermis of leaves.

Number of epidermal cells per microscopic field, number of stomata per microscopic field, length of epidermal cell, breadth of epidermal cell, perimeter of stomatal pore, length of guard cells and breadth of guard cells increased 8.21, 17.43, 9.18, 12.10, 1.51, 4.05 and 18.84; 5.68, 22.98, 10.31, 6.19, 7.91, 2.93 and 20.10; 5.47, 74.15, 10.00, 7.28, 2.98, 1.59, 20.07 percent with water extract under 6, 12 and 24 hrs treatments respectively on lower epidermis of leaves.

The stomata are principal portals through which gaseous exchanges take place between the intercellular spaces and surrounding atmosphere. The efficiency of stomatal apparatus
in controlling gaseous exchanges of the plants was extensively studied by Brown and Escombe (1900), who have pointed out that the rate of diffusion through small openings (like stomata) in a given period of time is proportional to the perimeter and not to the area of the pore. The greater the perimeter, the more rapid is the rate of diffusion. Earlier observations of Shukla (1967) revealed that application of 1 percent extract of _Phormidium foveolarum_ reduces the size of stomata in treated rice plants but increases their number and perimeter. Consequently, it was suggested that there would be more rapid diffusion of carbon dioxide in the leaves of treated rice plants. Similar influence of algal extracts on stomatal and epidermal development of wheat leaves (Shukla, 1975b) and synthetic growth substances on maize leaves has been recorded earlier (Shukla and Shukla, 1975).

Thimann and Skoog (1940) and Thimann, Rander and Byer (1942) used a plant ("_Lemna minor_") later identified as _S. oligorrhiza_ and used by Thimann and Edmondson (1949) for tests of auxin extraction methods. Extracts were assayed for auxins by the _Avena_ curvature test but no extraction was possible with water, or alkaline autoclaving. Sargent (1957) used both long and short-term extractions with ether or water, followed by paper partition chromatography
and *Avena* coleoptile section tests to assay the growth-active components in *L. minor*. Four growth-promoting substances and one inhibitor were found, their proportions depended upon the extraction techniques used. The major promoter was tentatively identified as indolacetic acid on the basis of its Rf value in the solvent system used.

The crude fresh extract of *S. polyrhiza* plants applied to wheat crop appears to contain growth substances, interestingly containing such a mixture of substances that provides an ideal blending of growth-factors sufficiently endowed to give general boost to the crop expressed in terms of altering growth, development, morpho-anatomy, metabolism and yield of wheat crop.

Present findings emphasized the significance of *S. polyrhiza* infestation, and how best they could be grown under *in vitro* mass culture and utilized for obtaining extracts which possess tremendous capacity to boost not only juvenile seedling growth and development of wheat crop but also exercised stimulation in vegetative growth, development and yield. The stomatal and epidermal structures also acquired better adoptability for gaseous exchanges vital for photosynthetic activity. Treatments also altered quality of wheat to the advantage by enriching them with higher protein and mineral
constituents thereby improving the quality of flour. The morpho-anatomical features following such treatments were so altered that render plants better adopted for life and productivity. The treated plants were not only intensely green with larger tillering and profuse development of broader and longer leaves but their stems and roots possessed better conducting tissues. This may partially explain the beneficial effect of *S. polyrhiza* extracts on growth of wheat plants.

Large infestation of *S. polyrhiza* plants with its known noxious importance is also endowed with great potential to multiply yield and alter quality of wheat crop. The findings are of paramount academic and applied significance, and are proven with promising possibilities for utilization of *S. polyrhiza* extracts by growers of commercial crop of wheat for higher and better quality wheat production.