CHAPTER  II

REVIEW OF LITERATURE
Though, there are a large number of drugs mentioned and practised for the treatment of urinary disorders in Indian system of medicine but 'PUNARNAVA' (*Boerhaavia diffusa* Linn.) was found most suitable because of its very popular use in the treatment of diseases of urinary system (Vonner and Varner, 1983) and the possibility of the presence of regenerative property in this drug as its name 'PUNARNAVA' suggests.

*Boerhaavia* is named in honour of the Leyden Physician H. Boerhaavia. The plant Punarnava (*Boerhaavia diffusa* Linn.) belonging to the family Nyctaginaceae contains the alkaloid "Punarnavine". The total alkaloid (punarnavine) content of roots is 0.04% (Chopra *et al*., 1956). The trade name is based on the Sanskrit name of the plant. In old Indian literature, it is refered to as "Sothaghna" i.e. destroyer of dropsy.

Punarnava (*Boerhaavia diffusa* Linn.), also known as "Rakta Punarnava", belonging to the family Nyctaginaceae is a popular
indigenous drug commonly used as a diuretic and urinary analgesic in the treatment of Oedema (Kritikar and Basu, 1933; Nadkarni, 1954).

The chief varieties of Punarnava are described—one with white flowers called "Sweta Punarnava" and the other with red flowers called "Rakta Punarnava". The extensive reference to this plant in Ayurvedic literature has attracted many scientific and several pharmacognostical workers (Prasad, 1948; Dutta and Mukherjee, 1952; Singh, 1969 and Surange et al., 1972, 1973).

Pharmacological (Basu, 1910; Chopra et al., 1923; Gujral, 1955; Basu et al., 1947; Karandikar et al., 1960; Harvey, 1966; Singh, 1969; Seth and Sethy, 1970; Mudgal, 1975, 1977 and Bhalla et al., 1971), Phytochemical (Chopra et al., 1923; Agrawal and Dutta, 1934; Singh, 1969, 1972; Mishra and Tiwari 1971; Srivastava et al., 1972 and Seth et al., 1986) and Clinical (Chopra et al., 1923; Singh, 1969 and Singh and Udupa, 1972) studies have been carried out on this drug in past.

Nadkarni (1954) has described various name of Boerhaavia diffusa in different languages:

Sans. : Punarnava, Shothaghni (cure of dropsy).
Eng. : Spreading hog-weed.
Hin. : Beshakapore; Gadhapurna; Thikri; Sant.
Punj. : Itsit.
Ben. : Gandhapurna; Sweta poorna; Punarnaba.
Bom. : Ghetuli; Satodimool; Motosatado.
Tel. : Attatamamidi.
Tam. : Mikkavatil; Mukurattai; Kadiyirattam.
Mal. : Tamiliama; Talutama.
Can. : Sanadika; Gonajali.
Mah : Punarnava; Khapra; Vasu.

Other Common Names:
Erva tostao, Pega-pinto, hog-weed
Fowl’s lice, Mahenshi, Purnoi,
Samdelma, San Sant, Santi, Thikri.

In the year 1985 the monogram of phytochemical investigation of plants by CCRAS described *Boerhaavia diffusa* Linn. (Syn. *B. ripens*) family Nyctaginaceae (Rakta-Puspa, Sothaghiai, Varyakatu) to posses following qualities (gunkarma) in Ayurveda:

- **Rasa** - Tikta
- **Guna** - Laghu
- **Vipaka** - Katu

Punarnava is vigorous, low growing, spreading vine with a long, tuberous tap root is some times considered invasive.
weed. Stems swollen at nodes cylindrical, grey or brown, slender or cylindrical, leaves 1.25-4.2 cm. long, opposite, simple, pairs unequal, broadly ovate, undersurface grey, upper surface dark-green, margin entire. Flowers pink or whitish, minute, in small, bracteate umbels of 4-10, arranged in long stalked axillary and terminal panicles; perianth funnel-shaped fruit an achene, ribbed, viscid on ribs, Punarnava is found in many tropical and warm climate countries. It is Indigenous to India where it is found in abundance in the warmer parts of the country, commonly found spreading and trailing on the ground, open pastures, fruit orchards and even found, pend anti on the old buildings. The punarnava plant flourishes well in rainy seasons but looks dull in winter and summer both.

Tribal and Herbal Medicine Uses:

The tap Roots of punarnava have held an important place in herbal medicine in Indian and other countries for many years. Punarnava is a plant medicine of great importance, extraordinarily beneficial for the treatment of liver disorders. It is employed in Brazilian herbal medicine to stimulate emptying of the gall bladder, as a diuretic, for all types of liver disorders (In Jaundice and Hepatitis), gallbladder pain and stones, urinary tract disorder, kidney stones, cyctitis and Nephritis. In India the roots are employed as a diuretic,
digestive aid, Laxative, and menstrual problems, to treat gonorrhea, internal inflammation of all kinds, edema, Jaundice, anemia, and liver, gallblader, and kidney disorders.

**Plant Chemicals:**

Noval plant chemicals have been found in Punarnava including-

Flavonoids, Steroids, Alkaloids, many of which drive its documented biological activities. The noval alkoloid found in Erva Tostao have been documented with immune modulating effects.

The main plant chemicals in this plant include:

Alanine, arachidic acid, Aspartic behenic acid, Boeravinone A thru F, Boerhaavic acid, BoerHAVINE, Bornave, Echysone, flavones, Galactose, glutamic acid, glutamine, Heptadecyclic acid, Histidine, Hypoxanthine, Liriodendrin, Oleaic acid, Palmitic acid, Proline, Punarnava vine, Serine, Sitosterols, Stearic acid, Threomine, Triacotan, Ursotic acid and Valine.

**Biological Activities and Clinical Research:**

Erva tostao (Punarnava) has long been used in traditional medicine systems as a diuretic (to improve urination) for many types of kidney and urinary disorders. The diuretic action of tostao has
been studied and validated by Scientists in Several Studies Research indicated that the root extract can increase urine output by as much as 100% in a 24 hour dosages as low as 10 mg/1 kg. of body weight.

The world wide use of erva tostao for various liver complains and disorders was done in three separate studies. These indicated that a root extract provided beneficial for the liver in animals by protecting the liver from numerous introduces toxins even repaired chemical induced liver and kidney damage.

In other clinical studies in animals, Erva tostao extracts demonstrated smooth muscle and skeletal muscle stimulation activities in frogs, in guina pigs, Antinflammation actions rats; Hypotensive in dogs as well as in vitro hypotensive actions; anti spasmotic actions in frogs and pigs; analgesic activities in mice and antiamebic actions in rats.

In Vitro testing of Erva tostao confirm antibacterial properties against gonorrhea as well as bacteris- Pseudo monan, Salmonella and Styphylococcus. It was also shown to possess actions against several viral plant pathogens.

**Ethnobotany of Punarnava**:  
In India the drug is used for various diseases as in Abdominal pain, Anemia, ascites, Asthma, Blood purification, Cancer,
Cholera, Constipation, Cough, Debility, Digestive slugishness, Dropsy, Dyspepsia, Edema, Eye problems, Fever, Gonorrhoe, Guinea worms, Hear oilment, Heart disease, Hemorrages (Child birth), Hemorrhages (Thoracic), Hoemorrhoids, Internal inflamation, Internal parasites, Jaundice, Kidney disorders, Liver support, Menstual disoeders, Renal insufficiency, Rheumatism, Snakebite, Spleen Enlargement, Urinary disorders, Weakness and as a diuretic and expectorant.


Pandey and Sinha (1972) reviewed the use of hormone in agriculture. Now a day IAA, IBA, NAA and 2,4-D are most widely used in soaking seeds for germination. Pre sowing treatment of seeds of *Phaseolus ureus* with IAA, IBA, NAA, 2,4-D etc. resulted as increase
in length of hypocotyl at low concentration and shortening at higher concentration. NAA and IBA are reported to stimulate germination of *C. Capsularis, C. olitoreus, Crotolaria juncea* etc. The accelerating effect of GA on germination of seeds of *Morus indica* was also reported.

The promotion of seed germination by light was noted in 1860 and inhibition in 1903 (Evenari, 1957, Toole *et al.* 1959). The repeated reversibility of the photoreaction which controls germination of lettuce seed was established in 1952 (Borthwick *et al.*, 1952 b).

Auxin isolated from urine was first demonstrated to have root forming property. Thimann and Went (1934), Thimann and Koepfli (1935) and Kogl (1935) proved that the root-forming/root-growth substance is identical to IAA. They also obtained better root growth in *Rhizopus* with the application of IAA. Chaudri and Gaur (1953) observed the inducing property of IAA for the formation of largest number of roots in Durania cuttings.

NAA has also been used for rooting with varying degree of success. NAA was also found to induce root formation in *Psidium guajava* L. (Singh, 1950). Singh and Teotia (1951) observed 100% rooting in mango var. Desehri and Langra and also observed inducing effect of NAA on rooting in Carica, Chorchorus and Euphorbia spp.
Sircar and Kundu (1960 b) and Mukherjee et al., (1964) recorded an increase in number and length of root in rice and water hyacinth with IAA and NAA. Gopalkrishnan (1964) and Sircar (1958) also obtained stimulatory effect on root growth in rice with the application of IAA.

It has, more recently, been found that action of auxin in roots is similar to that in stem, but that the concentration of auxin stimulatory to stem growth are inhibitory to root growth. In other words, roots are much more sensitive to auxin than stems, and real stimulation of root elongation may achieved if low enough concentration are used (Devlin and Jackson, 1961; Jackson 1960). Pandey and Sinha (1972) also reviewed the effect of NAA on mango varieties and noted that 10% NAA induced 100% rooting in Desehri while 20% in Langra. They also reported that not only root initiation is inhibited but that the stimulation of rooting caused by auxin is also counteracted. The inhibitory effect was observed in *Sorghum* and *Trifolium* spp. The application of relatively high concentration of IAA to roots not only retards root elongation but causes a noticiable increase in the number of branch roots.

The question of whether growth rates of roots correlate with their content of IAA has been approached with bioassay techniques and more recently, with an immunological procedure, a
radio immunoassay (Pengelly and Torrey, 1982; Wieler, 1984). A fairly good correlation was found between growth rate and IAA content. Mulkey et al., (1982) observed that higher concentrations of IAA (1 μM) were still strongly inhibitory. Synthetic auxins such as NAA and IBA are usually more effective than IAA. Similar results were also obtained by Went (1935) and Torry (1950) and Setterfield (1965) with growth hormone.

The work of several workers as reviewed by Black and Edelman (1970) on gibberellic acid shows that with the application of gibberellic acid to the leaf blade or in the axil, cabbage grow several feet tall and lettuce become vine like. Many dwarfs (e.g. dwarf maize, peas) treated with gibberellin have a long stem with little or no branching. In the cereals (e.g. maize and rice), internodal growth extension of leaf sheath and blade are all promoted.

Most dicots and some monocots respond by growing faster when treated with gibberellins (Pharis and Kuo, 1977). Cabbage and other species in the rosette from grow tall and then flower after GA₃ application, while untreated plants remain short and vegetative. Short bush beans become climbing pole beans and genetic dwarf mutants of rice, maize, peas, watermelons, squash and cucumber exhibit phenotypically tall characteristics of normal varieties when treated
with GA₃ or certain other gibberellins.

Phinney and Spray (1982) observed that only GA₃, controls stem elongation in maize. Similar new studies by Phinney suggest that only GA₃, controls stem elongation in rice and peas. Similar results were also observed by La Rue (1935), Mishra & Sahu (1957, 1958 a, 1959) with plant hormone in rice crop and coleus by Kumar and Gupta (1962) with GA₃ in forage crops and Nilsamranchit (1997) in medicinal plants. Yun-Ling et al., (1977) observed that application of GA to Arabidopsis thaliana L. in short day conditions resulted in rapid stem elongation and flower formation. Nilsamranchit et al., (1977) studied the effect of plant growth regulators on the growth in a medicinal plant, Ceranium and found that GA₃ treatments increased the number of leaves. Peng and Nicholas (1977) noted that plant growth and development are regulated by number of internal and external factors. Among these, gibberellin and phytochrome often influence the same process. In plants grown in the light Arabidopsis thaliana hypocotyl elongation is reduced by GA deficiency and increased by phytochrome deficiency.

The commercial powder, such as Rootex, in which cut ends of stem are dipped to facilitate root production usually contains IAA or NAA mixed with inert talcum powder.

The work on physiology of flowering has been extensively

Chailakhyan (1968), in his review, opined that flowering is a decisive stage in a plant’s life and attracts scientists attention because it precedes fruiting connected with the yielding ability of crop. Auxins and growth promoting substance, which function as auxins, have indirect influence, and do not play a decisive role in plant flowering; they can not be considered direct regulators of flowering.

Dostal and Hosek (1937) reported inhibition of floral initiation by applied IAA to the leaves of *Circaea*. Similar results were also found by Hammer and Bonner (1938) in *Xanthium*. Cholodny (1939) clearly formulated the view that high auxin levels in the soybean plant may be unfavourable to flowering. Mathur (1963) reported that treatments of NAA caused early flowering, whereas NOA and IAA delayed it. Lincoln and Hammer (1958) applied gibberellic acid (GA₃) to cocklebur and showed improvement in flowering behaviour. Harada and Nitsch (1959) showed that *Chrysanthemum* was not to induce flower by GA but the Japanese variety was induced to flower, Zhu & Davies (1977) working on pea lines (dwarf and tall) found an increase in flowering.
Mathur and Mittal (1964) obtained greater flower formation in cotton when gibberellic acid was sprayed on the cotton plant just before flower initiation. Chailakhyan (1968) reviewed that some gibberellins affect flowering while others do not, for example, in an experiment on Myosotis alpestris, GA₃ influenced only stem formation while GA₃ stimulated both stem formation and flowering.

Mathur (1963) studied the effect of auxins on boll-setting in cotton and found that the treatment not only caused significant increase in boll-setting, but also caused earliness. Crane (1964), in his review, opined that "fruit-setting by growth regulators is a function of their auxin-activity'. The significance of auxin in fruit has been recognised for over 30 years. Fruits such as egg plant, fig, grape, and tomato may be set by auxin application and their ultimate size and development may not be greatly different from their pollinated counterparts. Other fruits however, such as the apple, apricot, avocado, and pear may be set by auxin application but fail to grow to normal size. The majority of fruits, particularly of the drupe type such as cherry, peach, plum fail to respond to auxin application.

Malkani and Asana (1958) working on American cotton, obtained significant in yield of seed cotton per acre with the application of NAA. Das (1962) reported an increase in flowering and fruiting in pineapple with auxin. Mathur (1963) also observed
an increased in the yield of seed cotton when IAA was sprayed on the plant.

Fruits that can be set in varying degree with auxin, but also equally well or better with GA, are the tomato, fig, cucumber, egg plant, pepper, pear, apple, currant etc. The grape, particularly the Black corinth variety, has been widely and erroneously cited as responding to GA application by increase in fruit-set. Randhawa and Khanna (1959) and Randhawa and Dhuria (1959) obtained better fruitset, fruit size, total yield and quality of Phalsa and Sweet lime with GA₃. Crane (1964) has described, in his review, GA to be more effective than any other growth substance in fruit setting in tomato. Increase in fruit size over control as a result of GA treatment has been reported in the Black corinth and Thompson seedless grapes. Daniel (1996) also obtained an increase in tuber number and yield of potato with GA₃.

The production potentiality of any crop depends upon the supply of essential nutrients for their growth and development. Among the major nutrients (NPK), nitrogen is the most essential nutrient, hence it is also known as "Basis of Plant Life" which was known as synonym for fertilizer in this country where soils are generally deficient in this nutrient.

Research on crop physiological and agronomical practices
have been shown that the crop yield can be increased considerably with judicious application of fertilizers.

Nitrogen is very important nutrient for plants. Plant productivity is very largely determined by it. Nitrogen is also a most important constituent of chlorophyll, the role of which is very well known in the process of photosynthesis. The leaves of the plants growing with a low level of nitrogen compared with other nutrients are pale yellowish to radish green, which darken rapidly as the nitrogen supply increases and become very dark green when it is excessive. It is most important major and indispensable constituents of protein and nucleic acid that play fundamental role in metabolism, growth, reproduction and transmission of heritable characters. Moreover, protein forms the basis of enzyme responsible to control and regulate the biochemical changes at the time of germination to the stage of maturity.

The application of nitrogen favours the synthesis of protoplasm in plant body which is responsible for the cell division. Thus, nitrogen may bring an increase in the size of plant, yield contributing characters and finally the yield of a crop (Morton and Watson, 1948, Njoku, 1957).

Pramanik et al., (1996) revealed that crop fertilized with 100 kg N/ha gave the maximum yield. Arthamwar et al., (1996) also
reported that higher dose of nitrogen significantly improved all the yield attributed.

Singh et al., (2000) reported that application of nitrogen upto 120 kg/ha significantly increased the plant height, dry matter, leaf area index and chlorophyll content. Pandey et al., (2000) also reported that nitrogen applied in higher dose, produced taller plants and increased the maturity period. Burman et al., (2003) observed an increase in seed yield with the application of nitrogen. Similar results were also observed by Rana et al., (2003).

Phosphorus promotes healthy root growth and fruit ripening by helpful translocation of carbohydrates. An increase concentration of carbohydrate is also reported.

It is an essential element participating in the skeleton of plasma membrane, nucleic acid, many coenzymes and organic molecules such as ATP (Adenosine Triphosphate) and other phosphorytated products. It plays an important role in the energy transfer reactions and in oxidation reduction processes.

Phosphorus also plays an important role in activating cambial activity, tillering of crop plants, retention of premature leaf and fruit-fall, and controlling the formation of dead patches on leaves, petioles and fruits (Pandey and Sinha, 1979).

Singh et al., (1990) reported that the application of
phosphorus resulted significant increase in grain yield. Sankhyan and Sharma (1997) conducted an experiment and obtained an increase in grain yield with increasing phosphorus rate in maize. Bukeiv et al., (1999) recorded significant increase in dry matter of shoot, plant height, leaf area index, dry weight of leaf and grain yield of maize with phosphorus application.

Arya and Singh (2000) observed that application of 90 kg P$_2$O$_5$/ha resulted significantly more grain and straw yield of maize. Arya and Singh (2001) also obtained significantly higher leaf area index, dry matter accumulation, grain yield and straw yield of crop with phosphorus application.

Hussaini et al., (2001) obtained better growth and development of maize with the application of 20 and 40 kg P$_2$O$_5$/ha respectively.

Dhaka and Agrawal (1981) reported that 120 kg N/ha with 40 kg P$_2$O$_5$/ha produced the highest yield in sunflower. Kapur et al., (1984) reported that 60 kg N/ha with 40 kg P$_2$O$_5$/ha gave the highest yield but they also noted that the application of 54 kg N with 30 kg P$_2$O$_5$/ha was the best optimum fertilizer dose in Brassica juncea cv. RL-18. Sagare et al., (1986) worked on safflower to study the effect of nitrogen in combination with phosphorus and reported that application of 50 kg N/ha in combination with 50 kg P$_2$O$_5$/ha
produced more yield.

Potassium is found frequently in all the parts of plant but in fairly large proportion at growing points. It is considered that the whole of potassium in plant is present in soluble forms and most of it seems to be contained in the cell-sap and cytoplasm. Its utilization in plant is concerned with the formation of carbohydrate and proteins, photosynthesis, transpiration regulation, enzyme action, synthesis of nucleic acid and chlorophyll, oxidative and photophosphorylation, translocation of solutes etc. (Pandey and Sinha, 1979).

Singh and Pandey (1970) recommended 23-34 tons of Organic manure, 57 kg N, 57 Kg P and 27 kg K/ha to obtain satisfactory yield of chillies. Studer (1971) noted that suitable amounts of fertilizers for winter rape on calcareous clay soil are 180-220 kg N, 65-75 kg P₂O₅ and 120-150 kg K₂O/ha.

Bangash and Shaikh (1972) observed an increase in yield of Capsicum with NPK application. Dass and Misra (1972) also obtained better response of NPK an growth, yield and quality of chilli crop. Ray and Seth (1975) obtained more grain yield with Diammonium phosphate (18:46:0) than single Super phosphate, Nitro-phosphate (13:13:0) and more straw yield with Nitrophosphate (13:13:0) in wheat. Shekhawat et al., (1975) also reported that dwarf wheat varieties produced significantly more grain than tall ones when
supplied with NPK fertilizers. Similar results were also obtained in different crops by Somas et al., (1976), Belkins et al., (1977), Ludilon and Ludilon (1977), Pandey and Sinha (1979) and Bukeiv et al., (1999).

Tiwari et al., (1980) working on dwarf wheat cv. HD 1982 observed that the NPK fertilizers 13:13:20; 15:15:15 and 20:10:10 significantly increased the ear-bearing tillers, size of ears, weight of ears, grain number and grain yield/plant respectively. Bursukov and Lenenko (1982) reported that application of nitrogen in combination with phosphorus and potash (ie. N P K) increased the yield of linseed. Swamy and Bajaj (1988) reported that 75 kg N/ha with 50 kg P\(_2\)O\(_5\) and 25 kg K\(_2\)O/ha gave maximum response in mustard.

Nazeer and Tanki (1991) obtained an increase in height, spread, fruit size, number and yield of chilli cv. Shalimar Long with the application of 90 kg N and 90 kg P/ha respectively.

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