UTILIZATION OF WASTELANDS FOR GROWING MEDICINAL PLANTS

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Introduction

Plant resources are invaluable assets and socio-economic heritage of our country. Peninsular India is particularly rich in these resources, which include thousands of species of various categories viz. trees, shrubs, herbs and grasses. Medicinal plants constitute an important category and form an integral part of the rural and urban lifestyle. For betterment of health, medicines and medicinal plants become irreplaceable. Constant and unsystematic harvest of medicinal plants, which in majority occur as shrubs and herbs in forests in the form of undergrowth, are causing their fast depletion from the forests. Many of the species have reached the stage of "endangered and threatened", while demand of raw medicinal plant parts is increasing steadily with the coming up of more and more pharmaceutical companies in India and abroad. Hazardous effects of grazing and fire, particularly in Central india, together with over-exploitation have created havoc. Forests have been the chief source of raw material for majority of pharmaceutical industries. With the diminution of these in the forests, it has become essential to restore their overall status by introducing them in other available non-agricultural lands. Moreover, their constant supply is also essential for the existence of industries and security of public health. Further, tribals are, if not fully, but in majority dependent on locally available medicinal plants for curing their ailments. Very few of them go to the health centres. Some endeavour has been made in this direction to document the medicinal uses of herbs, shrubs, grasses etc. by tribals of Central India (Jain, 1963, 1975, 1981; Prasad *et al.*, 1990).

In this context it will not be out of place to mention that in India 93 million hectares of land is lying waste and several million hectares are suffering from erosion (Bhumbla and Khare, 1984). Over-exploitation of forest resources and diversion of land for agricultural and other purposes are main reasons behind this menace. Exposure of land to agencies of erosion has rendered it deficient in nutrients and less productive. Water and thermal stress in root zone restrict growth of plant species in such lands (Gupta and Aggarwal, 1988). As such, a few grasses, herbs and shrubs are found to occur on them. These lands are not suitable for growing agricultural crops economically. Further, several million hectares of forests are degraded due to various reasons. These lands can be effectively utilized for growing medicinal plants. Growing of medicinal plants in such lands will help in economic upliftment of tribals and conserving the gene pool resource available in the forests.

As stated earlier, majority of medicinal plants occurs in forests, therefore, they may be supposed to have symbiotic relationship with tree species. While developing wastelands through tree planting, the inter-space can be effectively utilized for growing medicinal plants. Thus, tree species will serve as nurse crop for medicinal plants. Since many of the medicinal plants are of Leguminaceae family, they are supposed to fix nitrogen symbiotically and eventually promote the growth of tree species and enrich the soil. Medicinal plants are considered to be hardy, require less care and can grow even on adverse sites. However, for better growth and obtaining more production per unit area, medicinal plants need to be selected on the basis of site and soil conditions.

Species suitability for different types of Wastelands

Selection of species for specific soil condition is of paramount importance for success of plantation and better economic return. This becomes far more important in the context of tribal development, tribals being poor and unable to bear the high cost of commercial cultivation. Low expenditure and better return is only possible through selection of suitable species for specific soils. Some references are available about the suitability of medicinal plants for different types of soils. These are mainly based on the natural occurrence of certain species in such types of soils. References of systematic research on suitability of medicinal plants for different types of wastelands are negligible. Table 1 depicts the suitable soils for some medicinal plants along with the references.

Singh *et al.* (1996) made an attempt to study the suitability of some medicinal plants for growing in different types of wasteland soils. They selected *W. somnifera, P. zeylanica, C. ternatea, A. augusta, A. moschatus* and *P. corylifolia* for study of their performance in different types of wasteland soils *viz.* skeletal soil, flyash, coal and copper mine overburdens and compared them with their growth performance in forest soil. Physico-chemical properties of selected soils are given in Table 2.

Biomass production of all species was found to be the maximum in forest soil, which is the natural home of medicinal plants except *Clitoria ternatea* and *W. somnifera* whose maximum biomass (143.0 and 32.2 g/plant) was observed in coal and copper mine overburdens respectively (Table 3). Species like *W. somnifera, A. moschatus* and *A. augusta* did not survive in fly ash. Coal and copper mine overburdens, skeletal soil and fly ash are very deficient in nutrients and possess adverse soil properties as is clear from Table 2. Except forest soil and skeletal soil, the Cation Exchange Capacity and exchangeable cations status of the spoils are very low. Fly ash is known for containing only pulverized fine ash particles. In spite of this, species like *P. zeylanica* (44.76 g/plant) and *P. corylifolia* (21.5 g/plant) performed better in it. It may be noted that coal and copper mine overburdens, which are considered to be very hostile sites for revegetation and biomass production, have also good potential for growing medicinal plants. Further, biomass production of all species was found to be higher in copper mine overburden than coal mine overburden. Skeletal soil responded better than fly ash, except in case of *P. corylifolia*, which produced higher biomass (21.5 g/plant) in

Table 1

Soil suitability for some medicinal plants

Species	Local name	Soil and climatic conditions	Reference
Withania somnifera	Ashwagandha	Soil which are not suitable for other crops. Occurs in drier part of India.	Anon., 1976
Plumbago zeylanica	Chitrak	Not available	-
Clitoria ternatea	Aparajita	Not available	-
Abroma augusta	Ulatkambal	Deep fertile alluvial soil with good drainage and well distributed rainfall.	Anon., 1985
Abelmoscus moschatus	Muskdana	Rich and well drained soil. Sub-tropical climate.	Anon., 1985
Psoralea corylifolia	Bawchi	Can grow on average soil	Anon., 1970
Andrographis paniculata	Kalmegh	Found on plains throughout India and Sri Lanka.	Anon., 1985
Solanum xanthocarpum	Bhatkatai	Occurs in warmer parts of India	Anon., 1988
Ruta graveolens	Ruta	Well drained calcareous clayey soil.	- do -
Hyocyamus niger	Khursani ajwain	Requires well drained fertile sandy loam or silt loam soil. Forest soils and wastelands rich in organic matter and free from weeds are suitable. Natural occurrence in western Himalayas from Kashmir to Kumaon.	Anon., 1991
Plantago ovata	Isabgol	Can be grown on variety of soils but does well in well-drained loamy soil. Suitable crop for sandy loam soil.	Anon., 1970

fly ash, but inferior to coal and copper mine overburdens. However, in case of *Clitoria ternatea*, more biomass was produced in skeletal soil (25.0 g/plant) than copper mine overburden (18.6 g/plant).

Use of amendments (compost) for increasing production

Degraded and wasteland soils are available in large quantities in India. According to Bhumbla and Khare (1984) about 175 million ha of land in India is suffering from degradation. Skeletal soil is an important category of wasteland, which covers vast area in India. In Madhya Pradesh alone, it covers 79,151 km^2 area (Biswas and Mukherjee, 1992). The soil is refractory in nature and contains high percentage of gravel, sand and silt, due to which it has low water retaining capacity and high porosity. The organic matter content is also low and has low nutrient status. Thermal and moisture stress and

Table 2

Physico-chemical properties of some wasteland soils.

Soil properties	Forest soil (Jabalpur)	Skeletal soil (Jabalpur)	Fly ash (Korba)	Coal mine overburden (Bishrampur)	Copper mine overburden (Malajkhand)
Sand (%)	64.00	67.95	-	69.50	52.80
Silt (%)	13.00	15.30	-	24.00	32.00
Clay (%)	23.00	16.75	-	6.50	15.20
Available Nutrients (ppm)					
N	178.50	31.36	39.60	23.20	31.20
P_2O_5	2.29	1.80	8.20	1.30	2.00
K_2O	112.00	57.36	36.40	81.20	150.00
Exchangeable Cations [Cmol (P^+) kg^{-1}]					
Ca^{2+}	48.80	23.10	-	1.50	2.00
Mg^{2+}	16.00	8.20	-	0.60	1.30
K^+	1.20	1.90	-	-	-
Na^+	0.20	0.20	-	-	-
pH	7.50	6.80	8.10	6.50	6.40
Org. C (%)	1.54	0.15	-	0.09	0.12

availability of nutrients are the limiting factors for growing plants in these lands. Addition of compost (FYM) may serve both the purposes. Compost is known to contain high amount of available nutrients and a host of micro-organisms, which are helpful in decomposing organic matter and improving soil properties. Compost has been found to be largely instrumental in increasing growth and biomass production of tree species in coal and copper mine overburdens (Williams *et al.*, 1994; Singh *et al.*, 1995).

Looking to the effectiveness of compost in increasing productivity, trials were conducted to observe the impact of various combinations of skeletal soil and compost on biomass production of medicinal plants (Singh *et al.*, 1998). The results obtained after 8 months of growth showed the maximum biomass of all species in 1:2 (soil : compost) combination (Table 4). However, the magnitude of response differed for different species in various combinations. It was important to note progressive increase in biomass with increasing proportion of compost. *P. zeylanica* showed least response in 1 : 0.5 combination of soil : compost with only 18.32 % increase over control, while the highest response in the same treatment was observed in *S. xanthocarpum* with 67.67% increase over control. The overall performance of different species was better in 1:1 soil : compost combination with

Table 3

Oven-dry biomass production of some medicinal plants in wasteland soils (g/plant).

Species	Oven-dry biomass production (g/plant)				
	Forest soil	Skeletal soil	Fly ash	Coal mine O.B.	Copper mine O.B.
Withania somnifera	12.8 (28.0)	6.6 (17.0)	Not survived	10.4 (33.5)	32.2 (100.0)
Plumbago zeylanica	84.2 (217.8)	48.5 (107.0)	44.76 (122.6)	48.9 (133.3)	65.6 (177.18)
Clitoria ternatea	80.5 (160.0)	25.0 (45.0)	15.5 (22.5)	143.0 (257.0)	18.6 (43.3)
Abroma augusta	63.2 (256.8)	36.8 (174.4)	Not survived	41.3 (177.0)	44.6 (193.2)
Abelmoscus moschatus	217.0 (820.0)	108.0 (480.0)	Not survived	143.5 (584.1)	168.0 (722.0)
Psoralea corylifolia	50.3 (153.3)	14.3 (46.0)	21.5 (61.5)	27.6 (83.9)	31.2 (94.9)

Figures within the parentheses indicate fresh weight (g/plant). O.B. - Overburden.

variation in biomass increase over control between 61.85 and 115.20%. The maximum increase was found in *S. xanthocarpum* followed by *A. paniculata* (94.09%) and *P. zeylanica* (93.33%). More than 100% increase in biomass was observed in all species in 1:2 soil: compost combination indicating its highest effectiveness. However, the maximum increase was observed in *S. xanthocarpum* (149.58%) followed by *R. graveolens* (147.16%), *P. zeylanica* (146.66%), *P. ovata* (146.45%) and *A. moschatus* (130.00%).

In some species the fruits have high medicinal value. Further, the seeds are the main source of multiplication and propagation of species. Hence, fruit yield of various species was also estimated in different treatments. The results obtained indicated maximum fruit yield of all species in 1 : 2 soil : compost combination (Table 5). The value of fruit yield of different species in this treatment ranged between 4.4 (*P. corylifolia*) and 30.7 (*S. xanthocarpum*) g/plant. It was important to note that even in the treatment 1 : 0.5 soil : compost, the increase in fruit yield in different species over control ranged between 19.0% (*P. corylifolia*) and 83.5% (*S. xanthocarpum*). The treatment 1 : 1 (soil : compost) was found to be superior with increase in fruit yield over control ranging between 66.6% (*P. corylifolia*) and 306.2% (*R. graveolens*). Other species also showed increase in fruit yield by over 100% 1 : 2 soil : compost was found to be the best treatment with increase in fruit yield between 109.5% (*P. corylifolia*) and 603.7% (*R. graveolens*)

Table 4

Biomass production of some medicinal plants in skeletal soil as influenced by application of compost in various proportions.

Species	Biomass production (g/plant) in different treatments (soil : compost)			
	1 : 0	1 : 0.5	1 : 1	1 : 2
P. zeylanica	15.00	23.00 (53.33)	29.30 (93.33)	37.00 (146.66)
A. paniculata	17.62	22.94 (30.19)	34.20 (94.09)	40.50 (129.85)
A. moschatus	24.46	30.10 (23.06)	41.80 (70.89)	56.26 (130.00)
P. corylifolia	13.92	16.47 (18.32)	22.53 (61.85)	28.02 (101.29)
S. xanthocarpum	24.87	41.70 (67.67)	53.52 (115.20)	62.07 (149.58)
R. graveolens	15.71	20.23 (28.77)	28.95 (84.28)	38.83 (147.16)
H. niger	16.56	20.25 (22.28)	25.67 (55.01)	34.49 (108.27)
P. ovata	7.32	9.97 (36.20)	13.61 (85.93)	18.04 (146.45)
W. somnifera	13.40	17.94 (33.88)	24.21 (80.67)	30.30 (126.12)

over control. Species like *P. zeylanica, A. paniculata, A. moschatus, H. niger* and *W. somnifera* showed increase over control by more than 200%.

Response of fertilizers on growth of medicinal plants

Fertilizers are known to increase growth of plant. Experiments conducted with tree species have shown several times increase in height and diameter of plants due to increasing doses of N, P and K (Singh *et al.*, 1996, 1997; Singh and Banerjee, 1999). Sheshagiri *et al.* (1984) reported boosting of vegetative growth in *Eucalyptus citriodora* due to application of nitrogen. Kanwar (1976) pointed out that excess nitrogen decreases cell wall thickness owing to poor development of mechanical tissues of stem. He is also of the opinion that growth response due to application of phosphorus might be attributed to its involvement in the basic

Table 5

Fruit yield of some medicinal plants in skeletal soil as influenced by application of compost in various proportions.

Species	Fruit yield (g/plant) in different treatments (soil : compost)			
	1 : 0	1 : 0.5	1 : 1	1 : 2
P. zeylanica	1.5	2.30 (53.3)	3.5 (133.3)	5.8 (286.6)
A. paniculata	1.9	2.5 (31.5)	5.0 (163.1)	6.2 (226.3)
A. moschatus	4.2	5.6 (33.3)	8.4 (100.0)	12.6 (200.0)
P. corylifolia	2.1	2.5 (33.3)	3.5 (66.6)	4.4 (109.5)
S. xanthocarpum	10.8	19.82 (83.5)	28.6 (164.8)	30.7 (184.2)
R. graveolens	0.8	1.33 (66.2)	3.25 (306.2)	5.63 (603.7)
H. niger	4.0	5.45 (36.2)	8.63 (115.7)	12.50 (212.5)
P. ovata	2.63	4.44 (68.8)	5.47 (107.9)	7.62 (189.7)
W. somnifera	2.7	4.42 (63.7)	7.20 (116.6)	8.80 (225.9)

reaction of photosynthesis. Potassium, according to him is required in photosynthetic reactions in using high-energy phosphates. Literature pertaining to fertilization of medicinal plants is very limited and scattered. Some information is available on response of fertilizer application to growth of few medicinal plants. Atal and Kapur (1982) recommended a fertilizer mixture of superphosphate, muriate of potash and urea each @ 50 kg/ha in medium type of soil for better growth and yield of *Solanum khasianum*. Kotoch *et al.* (1980) studied the effect of different level of N, P and K on herbage yields and digoxin content of *Digitalis lanata*. Prasad *et al.* (1989) made an attempt to quantify N, P, K requirement of *Solanum mammosum* for better growth and fruit yield. The soil had 12.9% sand, 27.6% silt and 59.5% clay, having pH 7.2. The organic matter content was 1.18% and CEC 44.8 Cmol (p+) kg^{-1}. The available N, P_2O_5 and K_2O were found to be 314.0, 25.6

Table 6 (a)

Effect of N and P on growth of Solanum mammosum [Average at 15 months (cm)]

N (kg/ha)	P_2O_5 (kg/ha) P_o	P_{50}	P_{75}	P_{100}	Mean
N_o	20.1	44.4	56.8	75.9	49.3
N_{100}	28.9	62.5	71.1	61.0	55.8
N_{150}	46.3	67.0	69.8	73.8	64.2
N_{200}	33.2	43.8	55.3	71.7	51.0
Mean	32.1	54.4	63.2	70.6	

Table 6 (b)

Effect of P and K on growth of Solanum mammosum. [Average at 15 months (cm)]

K_2O (kg/ha)	P_2O_5 (kg/ha) P_o	P_{50}	P_{75}	P_{100}	Mean
K_o	31.9	54.7	59.4	61.2	51.8
K_{50}	32.3	54.1	67.0	80.0	58.4
Mean	32.1	54.4	63.2	70.6	

Table 6 (c)

Effect of N and K on growth of Solanum mammosum.

	K_2O (kg/ha)				CD 5%	CD 1%
N (kg/ha)	K_o	K_{50}	Mean	N	7.945	10.565
	Average at 15 months (cm)			P	7.945	10.565
N_o	46.9	51.7	49.3	K	5.618	NS
N_{100}	45.0	66.7	55.8	N x P	15.893	NS
N_{150}	60.8	61.6	64.2	N x K	11.236	NS
N_{200}	48.4	53.6	51.0	P x K	NS	NS
Mean	51.8	58.4		N x P x K	22.475	NS

NS - Non significant

and 615.0 kg ha^{-1} respectively. Four levels of N (0, 100, 150 and 200 kg N/ha in form of urea), four levels of phosphorus (0, 50, 75 and 100 kg P_2O_5/ha in the form of single super phosphate) and two levels of potash (0 and 50 kg K_2O/ha in the form of muriate

Table 7 (a)

Effect of N and P on dry fruit yield of Solanum mammosum [Average at 15 months (cm)]

N (kg/ha)	P_2O_5 (kg/ha)				
	P_o	P_{50}	P_{75}	P_{100}	Mean
N_o	-	-	0.10	-	0.02
N_{100}	-	4.60	2.70	1.50	2.20
N_{150}	1.70	13.50	8.70	3.60	6.88
N_{200}	-	-	0.30	5.50	1.45
Mean	0.42	4.52	2.95	2.65	

Table 7 (b)

Effect of P and K on dry fruit yield of Solanum mammosum. [Average at 15 months (cm)]

K_2O (kg/ha)	P_2O_5 (kg/ha)				
	P_o	P_{50}	P_{75}	P_{100}	Mean
K_0	0.60	5.30	1.60	2.10	2.40
K_{50}	0.30	3.70	4.30	3.20	2.85
Mean	0.45	4.50	2.95	2.65	

Table 7 (c)

Effect of N and K on dry fruit yield of Solanum mammosum [Average at 15 months (cm)]

N (kg/ha)	K_2O (kg/ha)		
	K_0	K_{50}	Mean
N_0	-	0.05	0.02
N_{100}	0.77	3.65	2.21
N_{150}	7.12	6.65	6.88
N_{200}	1.77	1.12	1.45
Mean	2.41	2.86	

of potash) were applied in all possible combinations. The results obtained after 15 months of growth (Table 6 a, b, c) exhibited significant increase in height due to application of N up to the level of 150 kg/ha. The decrease in height was observed due to application of N at the rate 200 kg/ha in all combinations with P_2O_5 and K_2O with respect to N_{150}. Increasing level of phosphorus also increased the height significantly. Potassium was also found to be instrumental to some extent in increasing height of *S. mammosum.* The interactions N x P, N x K were found significant. The best treatment was found to be $N_{100}P_{50}$ and $N_{100}K_{50}$.

Fruit yield of *S. mammosum* increased markedly with the application of nitrogen up to 150 kg/ha. Further increase in the level of N decreased the fruit yield. Nitrogen seems to be essential in flowering and fruiting. 150 kg N/ha increased the mean dry fruit yield to 6.86 g/plant. Perusal of data also revealed that 50 kg/ha P_2O_5 increased the mean dry fruit yield to 4.10 g/plant. Further increase in P_2O_5 decreased the fruit yield (Table 7a). However, absence of P resulted in no fruiting and followed almost similar trend to that of the nitrogen. Application of K_2O @ 50 kg/ha in combination with N and P_2O_5 resulted in increase in mean dry fruit yield of only 0.45 g/plant over control (Table 7b and c). It was important to note that application of K_2O (@ 50 kg/ha) in combination with P_2O_5 (@ 50 kg/ha) resulted in increase in mean dry fruit yield by 4.05 g/plant (Table 7b), but further increase in phosphorus resulted in decrease in fruit yield. Thus, N_{150} P_{50} and $P_{50}K_{50}$ seems to be the best treatments for increasing fruit yield.

From the above results it may be inferred that wastelands can be effectively used for growing medicinal plants after application of proper amendments and selection of suitable species.

SUMMARY

Medicinal plants form an integral part of rural and urban lifestyle. But many of the species have reached the stage of 'endangered and threatened' because of over-exploitation of forests, uncontrolled grazing and fire. In India nearly 175 million ha of land is degraded, out of which 93 million ha is lying waste. This land is not suitable for growing agricultural crops economically but can be effectively used for growing medicinal plants after proper management. In this review, species suitability for different types of wastelands, proper amendments for boosting the growth of these plants etc. have been discussed in length.

औषधीय पेड़पौधे उगाने के लिए बंजर भूमियों का उपयोग

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सारांश

औषधीय पादप ग्रामीण और नगरीय जीवन शैली का अविच्छद्य अंग हैं । किन्तु इनकी बहुतसी जातियां संकटापन्न और विलुप्ति खतरे की स्थिति में पहुंच गई है जिसका कारण वनों का अति-समुपयोजन अनियंत्रित चराई और आग हैं । भारत में लगभग 1750 लाख हेक्टेयर भूमि व्याह्रसित है जिसमें से 930 लाख हेक्टेयर भूमि बंजर पड़ी है । यह भूमि कृषि फसलें उगाने के लिए आर्थिक दृष्टि से उपयुक्त नहीं है परन्तु समुचित प्रबन्ध द्वारा औषधीय पेड़पौधे उगाने के लिए प्रभावशाली ढंग से काम में लाई जा सकती है । प्रस्तुत समीक्षा में विभिन्न प्रकार की बंजर भूमियों के लिए पादपजातियों की उपयुक्तता, इन जातियों की बढ़वार में वृद्धि करने के लिए उपयुक्त सुधार आदि का विस्तारपूर्वक विवेचन किया गया है ।

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