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An Introduction of Medicinal and Aromatic Plants in Chir Pine (Pinus Roxburghii) Forest of India: A Sustainable Technique

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***Abstract*—In a scenario of decreasing availability of good lands for agriculture, declining forest, tree cover throughout the world, destruction through forest fire hazards, degrading soil and water resources, increasing pollution hazards and threats to the environment and ecosystem, innovative approaches in landscaping restoration and cultivation are required to meet food, fodder, timber, firewood, medicines and many other wood and non wood forest products for the 21st century. Keeping this concept in concept in view a trial was undertaken to introduce seven medicinal and aromatic plants (MAPs) in Chir pine (Pinus roxburghii) forest of mid hills of western Himalayas in India using agroforestry technologies which were developed as per the topography of the area in Dr. Yaswant Singh Parmar University of Horticulture and Forestry, Solan, H.P. (India) where seven MAPs namely Andrographis paniculata, Mucuna pruriens, Solanum khasianum, Spilanthes acmella, Withania somnifera, Cymbopogon nardus and Ocimum basilicum were grown during the year 2006-2007 and 2007-2008 on three aspects (Northern, Northwestern and Western) and under three tillage practices (Minimum, medium and deep) in both understorey of Chirpine and in open conditions. From an economic point of view Andrographis paniculata, Mucuna pruriens, Solanum khasianum and Spilanthes acmella were found to be better yielding and more remunerative in comparison to Withania somnifera, Cymbopogon nardus and Ocimum basilicum. The findings of the present investigation indicate that raising medicinal plant with Chir pine is a viable option for enhancing the diversification and rise in income from Chir pine forest. Hence these silvi-medicinal systems with agroforestry technologies can act as a key for landscaping and utilization of an unutilized land in and outside of Chir pine forest of India for socio-economic development of the rural people besides conservation of medicinal plant resources under in-situ conditions. This is likely to help in the sustainable development of the natural resources of the country.**

Keywords-agroforestry, tillage practices, aspects, diversification, silvi-medicinal system, medicinal and aromatic plants, conservation

I. INTRODUCTION

The increase in public interest in plant-based medicine coupled with rapid expansion of pharmaceutical industries necessitated an increase demand of medicinal plants, leading to over-exploitation that threatened the survival of many medicinal plants. Further, the degree of threat to natural populations of medicinal plants has increased because more than 90% of the plant raw material for herbal industries is drawn from the natural habitats. During last few decades, due to pressure of increasing population, the area of forest has been shrinking. Demand for medicinal and aromatic plants (MAPs) has been increasing due to the increased number of user and also due to resurgence of interest in herbal medicine and cosmetics. The variety, tonnage and values of medicinal herbs extract from forest are enormous. For example, more than 10,000 plants are used as medicines by the people of India, 70 % of which comes from the forests. While 90 % of the medicinal plants enter into the trade and industries are harvested from the wild sources. India exported about 1400 tonnes of plant products during the year 2000-2001[1]. Not surprisingly, wild plants species used for medicinal purposes are receiving ever-increasing attention from the scientific community and commercial enterprise. At the same time these species continue to support indigenous and local communities that have relied on them for centuries in their traditional medicines. But now a days, number of factors have threatened wild medicinal plants- habitat destruction, over-harvesting and big business. The erosion of plant diversity is not the matter restricted to country boundaries but it is of global concern. One by one the building blocks of entire ecosystem are disappearing, as about 8457 species are already threatened and redlisted. Hence actions at several levels is urgently needed to conserve the dwindling plant species.

India in particular has as wide range of soil and climatic variation in realms of degraded forests and waste lands which offer a unique situation to try different developmental

systems on land use to rehabilitate the environment with renewable green cover of economic species. As number of studies and survey reports have indicated that over exploitation of several of these medicinal plants for economic gain has rendered them as endangered or vulnerable species. The regeneration, protection and conservation of the medicinal plants are a serious challenge for restoring our biological heritage. The future of hundreds of plants species used for medicinal purposes in India which once grew abundantly in our forest and elsewhere are at a risk as they often are picked indiscriminately from the wild, leaving little scope for their regeneration. Another reason for disappearance of many species is ignorance on our part with regard to the knowledge of identity and use of such species. As ninety percent of medicinal plants in use today are obtained directly from the wild and are not yet cultivated, so traditional pattern of collection and utilization of medicinal plants is breaking under the changing social and economic structures. Considering the importance of medicinal plants for human health and well beings, there is a need for their cultivation and conservation under the agroforestry or under the man made tree plantation of the local area of habitat. Chir pine (Pinus roxburghii), which is one of the most important timber species in the subtropical region of India covering an area of 3853 Km2 in Himachal Pradesh has a wide adaptability, less demanding on soil and nutrient than other conifer[2]. The species has a wide adaptability, less demanding on soil and nutrient than other conifer. This is the cause of its being used in massive afforestation programmes in the country [3]. Thus keeping in view its role in massive afforestation programmes in the country, present studies are undertaken on the possibility of raising MAPs under Chir pine and utilizing the land under Chir pine plantation for its commercial exploitation and conservation of medicinal plant resources.

II. MATERIALS AND METHODS

A. Study site

The investigations were carried out at different topographical aspects in, Dr. Y.S. Parmar University of Horticulture and Forestry, Solan, Himachal Pradesh, India. The experimental site is located within 30o 51' N latitude and 76o 11' E longitude (survey of India Toposheet No. 55 F/1) at an elevation of 1250 m above mean sea level. The climate of the area is transitional between subtropical to sub-temperate with maximum temperatures rising upto 37.8oC during summer. The mean annual temperature is 19.8oC May and June is the hottest months whereas December and January are the coldest. The annual rain fall ranges between 800-1300 mm of which 75 per cent is received during mid June to mid September.

B. Field experiment design

Experimental field was prepared by removing the pine needles and tillage practices were done just before the onset of monsoon. Plots were prepared at the three topographical aspects viz. Northern, North-Western and Western at a spacing of 30x30, under different tillage depth viz. minimum (0 cm), medium (up to 10 cm) and deep tillage (up to 15 cm). The whole experiment was conducted under rainfed conditions entirely dependent on the monsoon rains. Keeping in view the forest site conditions no irrigation and fertilizer was applied. The plots for open condition were prepared at the open area of the forest itself, at the same topographical aspects. The raised nursery beds of size 2.0x1 m were prepared for transplanting of the seedlings. With the commencement of monsoon and after getting the sufficient moisture availability in the soil in first fortnight of July, healthy seedlings of MAPs were lifted from nursery and transplanted in the experimental field. In case of Mucuna pruriens direct sowing and in Cymbopogon nardus slips transplanting was done. Stacking was done to support the vines of M. pruriens. Hand weeding was done once in a season before the blooming. Harvesting of the economic parts of all MAPs was done as soon as the crop got matured in October to last week of January depending on the species and the aspect.

C. Assessment of tree attributes and crop yield

The present investigation was undertaken for two consecutive experimental years (2006 and 2007) in the Chir Pine forest consisting of Chir pine trees. The yield attributes of Chir pine viz. average height, average diameter and average value of crown area has been presented in table 1 and the average volume was calculated using local volume table based on diameter (Solan forest division). Annual increment in volume thus calculated, was then used to estimate returns from tree at the prevailing market price. The same procedure was used for calculating net returns from trees on all the three aspects.

TABLE I. YIELD ATTRIBUTES OF CHIR PINE

Aspect	Average height (m)	Average diameter (cm)	Crown area (m^2)
A_1:Northern aspect	11.23	19.94	2.99
A_2:North-western aspect	10.22	18.15	2.87
A_3:Western aspect	11.09	19.39	2.98

Growth and yield of MAPs integrated under Chir pine and without Chir pine (Open) on different aspects and under different tillage practices were studied separately by enumerating growth parameters like plant height, number of branches per plant, leaf area index, above and below ground dry weight.

To make the economic appraisal for medicinal crop based agroforestry system, the yield was subjected to economic analysis by calculating cost of cultivation, gross and finally net returns per hectare was calculated. The requirements of labour and other cultural operations such as Ploughing, weeding and harvesting were calculated as per prevailing rates, cost of seed was calculated on the basis per hectare requirement. The gross return in rupees per hectare

was calculate by using the prevailing local market prices to convert the yield and the net returns were calculated by deducting total costs incurred from the gross returns.

III. Results And Discussion

The production potential of MAPs can be judged by the Net returns at different aspects, tillages and systems. The bioeconomic appraisal of seven MAPs (Table 2), show that four species namely Andrographis paniculata, Mucuna pruriens, Spilanthes acmella and Solanum khasianum had the positive average annual returns. The remaining three species namely Withania somnifera, Cymbopogon nardus and Ocimum basilicum could not show economic viability as cost of cultivation was higher than the gross returns. The highest net returns were obtained for Spilanthes acmella followed by Mucuna pruriens.

Out of seven MAPs five namely Andrographis paniculata, Mucuna pruriens, Solanum khasianum, Withania somnifera and Cymbopogon nardus showed maximum value of net return on western aspect (Table 2) in comparison to other aspects which can be due to higher light interception corresponding to higher growth and yield. In case of remaining two MAPs namely Ocimum basilicum and Spilanthes acmella, northern aspect proved to be the best. The result can be supported by findings of [4] i.e. the Northern aspect receives less direct sun-shine, lower temperatures and high moisture retention which inturn create ideal agro-climatic conditions for the cultivation of these two species while the southern and western aspects receive more direct sunshine and consequently can support light demanding species. The difference in temperature on the different aspects of hills can also be explained in terms of differential isolation i.e. by proximity or distance from the equator, for example isolation factor for the southern aspect is about 1.5-2.4 times higher than that for the northern aspect.

However in all the MAPs the higher values of net returns (Table 2) was found under deep tillage in both understorey and open conditions, which can be due to better soil permeability, soil aeration, root penetration and weed control [5]. It is also reported that development of roots was better in less compacted soil whereas dense soil markedly reduced root growth [6]. Similarly the effect of polughing depth was observed on the development root system [7].

The highest net returns 104887 (Rs/ha) for Spilanthes acmella growing on western aspect under deep tillage in open conditions is due to highest gross returns obtained for this species. The negative returns for Withania somnifera, Cymbopogon nardus and Ocimum basilicum is attributed to their higher cost of cultivation than the gross returns. The lower gross returns for these species is because of their poor economic yield in understorey and open conditions due to compact soil and rainfed conditions.

The positive net returns in case of Andrographis paniculata, Mucuna pruriens, Spilanthes acmella and Solanum khasianum may be due to their suitability in the environment given in open conditions and in association with the Chirpine. This finding can be supported by [8] who initiated a research to determine the separate effects of above and below ground competition and needlefall from overstorey pines on understorey plant performance and found that depending on species the effects of needlefall were positive, negative, or negligible.

The positive net returns in Andrographis paniculata, Mucuna pruriens, Spilanthes acmella and Solanum khasianum are also attributed to lower cost of cultivation than gross returns. The lower cost of cultivation in the given conditions can be due to three distinct reasons viz. the lower rental value of land in association with Chir pine in understorey and open conditions; no application of fertilizers and irrigation practices and lower cost of planting material as the respective nursery was prepared for Andrographis paniculata, Spilanthes acmella and Solanum khasianum . The direct seeding was done in case of Mucuna pruriens in the given conditions.

Thus the successful cultivation of these species namely Andrographis paniculata, Mucuna pruriens, Spilanthes acmella and Solanum khasianum can be recommended only in the wasted land having lower rental value like land in association with Chir pine. This finding can be supported by [9] who reported that targeted species like Andrographis paniculata etc. could better flourish on natural ecosystem under in-situ conditions and the conservation and cultivation of these species under controlled cultural practices did not prove to be economically feasible under ex-situ.

IV. Conclusions

The successful cultivation of such species namely Andrographis paniculata, Mucuna pruriens, Spilanthes acmella and Solanum khasianum can be recommended for waste lands having lower rental value like land in association with Chir pine. Thus the combination of such MAPs with forest tree species will not only ensure their regular supplies but also their conservation. Such practices will utilize lands like understorey of Chir pine which remained unexploited since years, improve rural livelihood and country's economy. This practice is also likely to reduce the fire hazards which are reportedly harming the forest since years because such kind of activity will not allow the flammable needles to accumulate in bulk the understorey.

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TABLE II. AVERAGE ANNUAL NET RETURNS (RS/HA) FROM MEDICINAL AND AROMATIC PLANTS IN UNDERSTOREY OF CHIR PINE AND OPEN

Treatment combination	*Andrographis paniculata*	*Mucuna pruriens*	*Spilanthes acmella*	*Solanum khasianum*	*Withania somnifera*	*Cymbopogon nardus*	*Ocimun basilicum*
$A_1T_1S_1$	4042	15567	34639	2879	-4534	-37963	-2577
$A_1T_2S_1$	4661	14640	84584	2830	-4784	-38833	-2939
$A_1T_3S_1$	6359	14200	107971	3732	-4832	-38399	-3039
$A_1T_1S_0$	2434	11840	51874	4808	-7989	-27087	-6166
$A_1T_2S_0$	2902	11094	114465	4497	-8172	-24899	-6225
$A_1T_3S_0$	4136	10294	139345	8344	-8607	-22828	-7021
$A_2T_1S_1$	3950	14643	26657	2648	-5301	-38594	-3574
$A_2T_2S_1$	5342	13876	76402	4188	-4745	-39435	-3958
$A_2T_3S_1$	5799	13098	95657	7938	-4811	-39200	-4651
$A_2T_1S_0$	2105	11350	44177	5345	-8471	-25669	-6797
$A_2T_2S_0$	3704	10658	103402	5164	-6606	-24048	-7030
$A_2T_3S_0$	4648	9735	121372	8998	-6691	-22918	-7964
$A_3T_1S_1$	5833	13898	17481	2610	-5296	-39068	-4513
$A_3T_2S_1$	8104	13480	65919	4833	-4304	-39594	-4674
$A_3T_3S_1$	9150	12469	79352	9321	-4175	-39407	-5599
$A_3T_1S_0$	3535	10547	30361	5698	-8202	-24318	-7823
$A_3T_2S_0$	6324	9701	87572	5799	-6237	-23722	-8293
$A_3T_3S_0$	7027	8685	104887	9477	-5671	-22800	-9413

A_1= Northern aspect, A_2= North-Western aspect, A_3= Western aspect

T_1= Minimum tillage, T_2= Medium tillage, T_3= Deep tillage

S_1= Understorey, S_0=Open

Out put price of:

* *Andrographis paniculata* Rs. 18/ Kg (Year 2006 for, Solan H.P.) – Herbal market Spectrum, India
* *Mucuna pruriens* Rs. 15/ Kg (Year 2004 for Solan, H.P.) – Herbal market Spectrum, India
* *Solanum khasianum* Rs. 30/ Kg – National medicinal plant board (2008), India
* *Spilanthes acmella* Rs. 300/ Kg (Year 2001)- Unnati cooperative Talwara (For Above ground dry herbage), India
* *Withania somnifera* Rs. 60/ Kg (Year 2006 for Solan, H.P.) – Herbal market Spectrum, India
* *Cymbopogon* oil: Rs. 300/ Kg (Year 2008) – Fragrance and flavour development centre, Kannauj, India
* *Ocimum basilicum* Rs. 250/ Kg: Ref- Purohit and Vyas (2004), India
* Chir pine = Rs. 813 per m^3 standing volume – H P Govt. of India Notification No.F FE-B-A(4) 3/2005