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REVIEW ARTICLE

Integrated weed management of medicinal plants in India

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Abstract: The present as well as future need is to diversify the agro-ecosystem and to minimize or overcome the bad effects of global warming and climate change. Medicinal plants survive very well in the current scheme of crop diversification in various types of agro-climatic conditions of India. Agronomists are posed with challenge of scientifically fitting most suitable medicinal plants in different ago-climatic regions. Among the losses caused by different pests in the agriculture, the weeds account for about 45% and it may be more or less equal in the case of medicinal plants. Integrated weed management increases the factor productivity, income of the farmer, quality of produce and is eco-friendly in nature. By taking examples of two important medicinal plants viz. Satawar (*Asparagus racemosus* Willd.) and Kalmegh (*Andrographis paniculata* Nees.), the present review discusses the different methods of weed management and how they may be integrated to develop new paradigm as an integrated weed management.

Keywords: Integrated; Weed; Medicinal; Satawar (*Asparagus racemosus*); Kalmegh (*Andrographis paniculata*).

Introduction

Presently Indian agriculture is at cross roads. Increasing demand for food, feed, fiber and fuel coupled with issues of economics & environment in agriculture have posed challenges to scientists, policy makers, farmers and industry. The excessive use of chemical fertilizers is creating soil, water, plant and system pollution which is leading to chronic diseases in human beings. As consumption of excessive drugs by human beings is harmful, therefore more and more people are now using natural or traditional medicine. Medicinal plants required for manufacturing of Ayurvedic medicines are facing threat of overexploitation due to their excessive collection from natural habitats. Therefore, the present need is to grow medicinal plants in agro-ecosystem by the farmers on waste land. Kothari et al. (1987) have reported that medicinal plants based cropping system in north India has tremendously increased profit of the farmers. Like agricultural crops various constraints pose serious problem for cultivation of medicinal plants viz. nutrient management, water management, suitable genotype, agro-climatic condition and weed management. Satisfactory research work on the aforesaid constraints has been done by some scientist at different places of the country but little work has been carried out on the weed management, which is the major constrain for cultivation of medicinal plants. In many other crops, among the losses caused by different pests, the weed accounts for nearly 45% and it may be similar in case of medicinal plants. Weeds also interfere with crops to utilize nutrient, soil moisture and space that ultimately suppresses the plants growth, reduces yield and quality of produce of medicinal plants.

If these weeds could be managed by employing the tools of weed management in inte-

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grated approach, then it can minimize the weeds below the economic threshold level (ETL) and improve yield, yield contributing character and quality of medicinal plants. As well as this approach will be eco-friendly in nature. The present paper highlights the role of the integrated weed management to minimize weed population and improve the quality of medicinal plants by taking examples of two important medicinal plants viz. Satawar (*Asparagus racemosus* Willd.), Kalmegh (*Andrographis paniculata* Nees.).

Importance and Scope of Medicinal Plants

Medicinal plants have played a significant role in many ancient traditional systems of medicine in Asia viz. Ayurvedic and Unani systems of medicine in India, Chinese traditional system of medicine, as well as their derivative in most Asian countries. At present, medicinal plants play an important role in both developed and developing countries of Asia. In addition, they also generate income to the people of many Asian countries, who earn their living from selling of the materials collected from wild or through cultivation. Collection of naturally occurring medicinal plants is being done in Asia since pre-historic time. At present, such activity, although limited in amount in most countries, is still carried out with the objective of using them in traditional medicine or for processing into pharmaceutical products. Such activity generates income to the native people and provides rare raw material at a lower cost, which is not available through cultivation. However uncontrolled collection of medicinal plants creates problem of genetic erosion and is unsustainable.

In India, nearly 9500 registered herbal industries and multiple unregistered cottage level herbal units depend upon the continuous supply of medicinal plants for manufacture of the herbal medicine formulation based on Indian system of medicine. Whereas more than 6000 higher plants species are estimated to be used in the codified and folk health care tradition in the country. The quantum of their consumption has remained the matter of guestimate. The fallout is the lack of the reliable species wise demand estimates. Due to inadequate management of medicinal plants in the country, the proper management of medicinal plant is an important concern at present time. Due to ever increasing demand for the herbal medicine at present time there is great scope for the cultivation of medicinal plants on large scale. The annual demand of botanical raw drugs in the country was estimated as 3,19,500 MT at an cost of Rs. 1069 crores (1 crore = 10 million) for the year 2005-06 (Table 1). Amla (*Emblica officinalis*) is the highest consumed raw drugs material by the domestic herbal industries, export of Isabgol (*Psllium husk*), Senna (leaves and pod), Henna (leaves and powder) and Myrobalans account for nearly 70% of total export of plant raw materials for the drugs on the volume basis.

Table 1: Estimated annual demand (dry weight in MT) and trade value (Rs. in crore) of botanical raw drugs (2005-06).

Particulars	Herbal industry	Rural household	Export	Total
Demand	1,77,000	86,000	56,500	3,19,500
Trade value	627.90	86.00	354.80	1068.70

Satawar (*Asparagus racemosus* Willd.) and Kalmegh (*Andrographis paniculata* Nees.) are two very impotant medicinal plants, which play an important role in income of people belonging to weaker section in rural areas. Satawar is used in a medicine for different types of diseases and weakness i.e. it increases lactation after birth of the child, etc. Kalmegh is a boon for the poor people of the rural areas because it is used as cure for fever, jaundice, malaria, fever and some other chronic diseases. So these two plants are very important for people of rural areas as medicine and cash crop.

Present scenario

Due to increase in demand of medicinal plants with each passing year, wild resources of many medicinal plants, which are major source for the herbal industries, are facing a serious threat of extinction due to indiscriminate harvesting. For facing such type of problem the only one option is to cultivate the medicinal plants at large scale on the waste land, degraded land and problematic land without affecting the area

sown for food grain production, because food security is also important. If medicinal plants have to be cultivated on large scale, then many types of bottlenecks will have to be taken into account viz. nutrient management, water management and weed management. In field of medicinal plants many types of experiments have been conducted on nutrient management, water management etc. But as far as weed management is concerned very few experiment have been conducted in India and abroad. Till 1980s very little information was available on the nutrient studies of MAPs. In a series of field experiments conducted at Central Institute of Medicinal and Aromatic Plants (CIMAP), Lucknow, it was recorded that, Pamarosa (*Cymbopogon martini* Roxb. Wats.) had high capacity of removing nitrogen (430.4 kg/ha/2yr.) as compare to Java (181 kg/ha/2yr.) and Lemmon grass (160 kg/ha/2yr.) (Prakasa Rao and Puttanna 2006). Pama rosa have high Nitrogen use efficiency as compare to other grasses. Micro nutrient also play vital role in biosynthesis of essential oil and their constituents (Misra and Sharma 1991; Misra 1995). In semi arid tropical conditions, optimum scheduling of irrigation and its relation to yield and qualities of essential oils have been reported by Prakasa Rao et al. (2000). In northern Indian plain condition, some workers have highlighted the role of optimum water management in economically important mint spp. (Singh et al. 1989). Pank et al. (1980) reported that the utilization of a sequence of herbicides led to a 90 % reduction in weed cover. Manual work reduced weed cover by 65 % (Wanq et al. 2000) reported that Haloxyfop is a herbicide, which acts slightly on the growth of *Bupleurum falcatum*, but effectively kills many other kinds of weeds. Butralin is a good herbicide for Gramineae.

Perusal of literature revealed that very few studies have been made on the weed management in medicinal plant. Weed compete with the medicinal plants for nutrient, light, space, moisture and temperature, which ultimately reduces the yield, yield contributing character and quality of medicinal plants, and it also reduces the efficiency of farm resources. So, if these weeds could be managed by integration of all the weed control measures like physical, cultural, chemical and biological, then it will surely minimize the weed population below ETL, reduce competition for growth and development, and provide favorable condition for balance growth of the medicinal plants. By and large, it is clear that by applying integrated weed management (IWM) in medicinal plant like Satawar and Kalmegh, we can achieve higher return per unit investment and also increase farm income.

Losses caused by weed

Weeds are unwanted and undesirable plants which interfere in the utilization of land and water resources and thus adversely affect human welfare (Rao 2000). Weeds are an important factor in management of all land water resources, but their effective impact is greatest on agriculture. A weed is any plant growing where it is not wanted. Remember, “One gardener’s weed is another gardener’s wealth.” The plants that we generally all agree as "weeds" are typically hardy, reproduce easily, and are very competitive with other plant species.

The losses caused by weeds exceed the losses from any other category of agricultural pests, such as insects, nematodes and rodents. Among the total annual losses of agricultural product from various pest, weeds account for 45 %, insects for 30 %, diseases 20 % and other pest 5 % as shown in Figure 1 (Rao 2000)

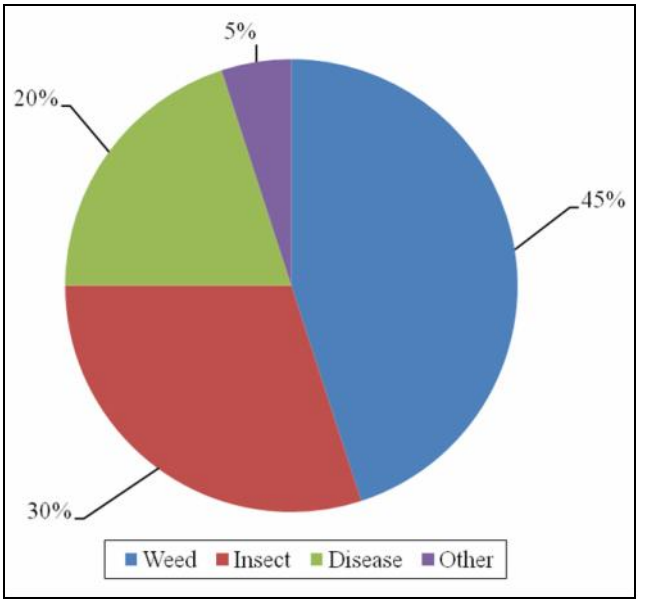

Figure 1: Losses caused by different pest in agricultural produce (%).

Following are the various types of losses caused by weeds to medicinal plants:

(i) Nutrient losses caused by weeds by competition for essential nutrients.

(ii) Reduces the yield contributing character by creating space competition on the above and below the ground surface.

(iii) Loss in soil moisture.

(iv) Reduces the quality of medicinal plants by adulteration/ mixing of weeds during post harvest processing. The root of kans grass (*Cyperus rotundus*) also reduces the quality of root crops like *Asparagus*, *Chlorophytum*, etc.

(v) Weed drastically reduces the yield of medicinal plant as well as farm income.

(vi) High intensity of weed leads to slow germination and initial growth, wider row spacing and slow lateral spread, which causes tremendous loss in productivity as well as quality.

Various types of weed floras are found in cultivated fields of Satawar and Kalmegh. Some dominant weed floras of these crops are given in table 2.

Table 2: Weeds found in fields of Kalmegh and Shatawar.

Type of weed	Botanical name	Common name	Family
Sedge	*Cyperus rotundus*	Motha/Nutsedge	Cyperaceae
	Cyperus iria	Motha/Nutsedge	Cyperaceae
	Cyperus diformis	Motha/Nutsedge	Cyperaceae
Grasses	*Echinochloa crusgalli*	Sewai	Poaceae
	Echinochloa colonum	Dawra	Poaceae
	Cynodon dactylon	Doobghas	Poaceae
	Eleusine indica	Goose grass	Poaceae
	Panicum spp.	Witch grass	Poaceae
Broad leaf	*Ammania baccifera*	Ammania	Lythraceae
	Acalypha indica	Indian copperleaf/ Cat's tail	Euphorbiaceae
	Amaranthus virdis	Amaranth	Amaranthaceae
	Phylanthus niruri	Hajardana	Euphorbiaceae

Need for Integrated Weed Management?

Integrated weed management is a weed population management system that uses all the suitable techniques in a compatible manner to reduce weed population and maintain them at levels below those causing economic injury (Shashikumar and Saravankumar 2007). No single method is able to control weeds in satisfactory manner, which creates problem of resistance in weeds. Usage of same control methods leads to buildup of tolerant weeds in Satawar and Kalmegh. It is uneconomical to eradicate all weeds because some may provide food and shelter to insect predators and predators that reduce other pests. Therefore, if we apply all the control measure in integrated form then weed can be minimized and controlled effectively in important medicinal plants like Satawar and Kalmegh.

Integrated Weed Management in selected medicinal plants

It symbol like a penta star and seen it as a star, the effect of IWM is also like a star i.e. control the weed population in eco-friendly nature.

Cultural methods

Different cultural method of weed control that can be effectively applied to medicinal plants viz. Kalmegh and Satawar are given as under-

(i). Field sanitation- Field is kept clean by ploughing.

(ii). Planting material- Planting material of Satawar and Kalmegh should be free from weed seeds.

(iii). Variety selection- Select fast growing variety, so they can easily cover the soil surface.

(iv). Planting density/spacing- Planting of Satawar and Kalmegh should be done at close spacing i.e. 50 and 30 cm, respectively. The closer spacing of planting suppresses the weed population.

(v). Cropping system- Crop rotation, intercropping and mixed cropping with Satawar and Kalmegh reduces the weed infestation.

(vi). Competitive or smother cropping- Cow pea or Lucern grown in wider space of Satawar and Kalmegh, due to quick germination, form larger foliage and deep root system, which exerts their influence against weed seedling. It also provides nitrogen to Satawar and Kalmegh.

Physical Method

(i). Hand weeding- Among the physical method of weed control the hand weeding is most common, due to its high cost it is uneconomic, but if integrated with IWM then it may become economical. Hand weeding at 20 and 40 days after sowing (DAS) or days after planting (DAP) is most sensitive for weed control in Satawar and Kalmegh, because early stage is most sensitive for weed competition.

(ii). Hand hoeing- Hand hoeing by spade or kudal in space between two rows of Satawar and Kalmegh at later stage is best for vegetative growth, because at this stage if hoeing is done then it suppress the weeds as well as provide conducive condition for higher growth of root and shoot of the Kalmegh and Satawar.

(iii). Mulching- Mulching plays an important role in both terms i.e. control the temperature and suppress the weed growth.

Biological control

Using bio-agent to control the weed is known as biological control of weeds. It is eco-friendly in nature for example *Zygograma* is used for controlling *Parthenium hysterophorus*. Fungi are used for controlling water hyacinth. Application of Bipolaris i.e. myco-herbicide provide better control of *Sorghum helepense* i.e. weeds in Satawar and Kalmegh.

Use of living organism viz. insect, diseases organism, herbivorous, fish, snails, or even competitive plants for the control of weeds is called biological control. It is less harmful to environment because of no residual effect. It is relatively cheaper, safe in use and does not affect non target plants.

Chemical control

Use of organic and inorganic chemical constituents to kill or minimize the weeds is known as chemical control of weeds. Classification of chemical herbicides (Katyayan 2007):

- Inorganic herbicide - Sodium chlorate, sodium arsenate, copper sulphate, copper nitrate.
- Organic herbicide- Organic acids, diesel oil and salts.
- Selective herbicide- Those herbicide kill only target spp. ex. simazine, atrazine and 2,4-D.
- Non-selective herbicide- Those herbicide kill both target and non target plants spp. are called non-selective herbicide. ex. paraquat and diquat.
- Systematic herbicide- Herbicides that enter in the plant system for its activation are called as systematic herbicide. ex. simazine.
- Contact herbicide- Herbicides that kill only the portion of plant that come in contact of herbicide are called contact herbicide. ex. paraquat, diquat.
- For the control of weeds in Satawar, the most suitable herbicide is pendimethalin @1.5 kg a.i. ha. pre-em. If it is applied at-preemergence stage of crop then it has less bad effect on Satawar. 2,4-D @ 0.5 kg a.i. ha post-em. at 35 DAS also provides better results for controlling weeds in Satawar because it kills broad leaves weed and it does not affect Satawar due to its narrow leaves.
- In case of the Kalmegh, the pendimethalin @1.5 kg a.i. ha. pre-em., metribuzine, simazine and atrazine may be given for better results for controlling weeds in Kalmegh.

Genetical methods

Manipulation of herbicide resistant gene in cultivated medicinal plants that facilitate application of those herbicide i.e. non selective.

Conclusion

Nutrient and water studies made in semi arid tropical region have shown that qualities of essential oil were not affected by chemical fertilizer (Prakasa Rao et al. 1997). Rajeswara Rao et al. (1996) reported that deficiency of micronutrient have adverse impact on quality of essential oils. So by keeping aforesaid facts in mind, the use of herbicides at appropriate rate and in integrated manner may be economical and it does not affect the quality of medicinal plants viz. Satawar and Kalmegh. All the weed management practices applied in integrated approach in the cultivation of Satawar and Kalmegh for controlling or minimizing the weed infestation or population below economic threshold level (ETL), then losses caused by such various types of weeds to be minimized. It also help in better utilization of input like land, labour, nutrient, water, solar etc. and enhances the production, productivity and quality of medicinal plants viz. Satawar and Kalmegh in sustainable manner. Due to its integrated form of weed management also reduces the cost of cultivation as well as environmental and soil pollution.

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