INTRODUCTION

Changing scenario of herbal market and expanding global trade has opened up a new prospective for Indian agriculture. Medicines are the second most essential requisite after food for mankind. Medicinal plants are the important sources of raw drugs. The demand on plant based therapeutics has increased many folds in both developing and developed countries. They are natural products, non-narcotic, having no side effects and are easily available at affordable prices. Due to huge demand of plant-based crude drugs, throughout the world, there is an urgent need to domesticate or cultivate the medicinal plants. For genuine quality material, cultivation of medicinal plants and harvesting them at the appropriate time is essential. Each medicinal plant species has its own demand for nutrients, water and other parameters. The cultivation practices as well as post-harvest technology plays an important role for successful plantations, storage and trade of these plants. But due to lack of systematic information on cultivation of medicinal crops, growers are reluctant to adopt such practices. Medicinal crop cultivation relies heavily on quality seeds. Seed quality is of vital, in its absence, expenditure of farmers on the other inputs viz., fertilizer and irrigation may be of little value. There are various seed quality parameters namely, seed germination, physical purity, genetic purity, seed moisture and seed health which are the pre-requisite for seed quality assurance. The Seeds Bill (proposed) 2004 emphasizes fixing the minimum seed standards in respect of all categories of seed made available to the farmers. Such standards would protect the interest of the farmers by conforming to the minimum limits of seed quality parameters. Keeping view of their varied therapeutic potential, considerable economic value and need for cultivation and their seed quality parameters, the two experimental systems ashwagandha (Withania somnifera (L.) Dunal) and kalmegh (Andrographis paniculata Nees) were chosen for the present study.
Ashwagandha, a member of family Solanaceae is one of the most important medicinal plant, known as asgandh, nagouri agandh and punir. Ashwagandha in Sanskrit means “horse’s smell”, originating from the odour of its root which resembles that of “sweaty horse”; it tastes bitter and acrid. The species name *somnifera* means “sleep bearing” in latin, indicating it was considered as sedative. Some herbalists refer to ashwagandha as “Indian ginseng”, since it is used in ayurvedic medicines, alike Chinese ginseng used in traditional medicine. It is a small or middle-sized shrub, about 30 cm to 1.5 m in height. Stem and branches are covered with minute star-shaped hairs. Leaves are simple. Flowering in ashwagandha occurs nearly throughout the year. It bears small (about 1 cm long) greenish or yellow flowers. Fruits are globose, smooth, red and enclosed in an inflated and membranous calyx. There are one or more tuberous roots. The plant grows from sea level to an altitude of 1,500 metre above sea level. The estimated production of ashwagandha roots in India is more than 1,500 tonnes (Chadha, 2007) and the annual requirement is about 7,000 tonnes, necessitating the increase in its cultivation and higher production. Roots contain alkaloids- withaferin-A, 12-deoxywithastramanolide, withanolide etc. The plant is used as anti-stress, anti-inflammatory, anti-oxidant, anti-tumor agent and also reported to have anti-carcinogenic effects in animal and cell cultures (Uma Devi et al., 1993; Uma Devi, 1996; Singh and Kumar, 1998).

Kalmegh, a member of family Acanthaceae, another chosen experimental system is an erect annual herb and is extremely bitter in taste (each and every part of the plant body). The plant is known in north-eastern India as ‘Maha-tita’, literally ‘King of bitters’ and known by various vernacular names. It is also known as ‘Bhui-neem’, since the plant, is much smaller in size, shows similar appearance and has bitter taste as that of neem (*Azadirachta indica*). Incidentally, the genus *Andrographis* consists of 28 species of small annual herbs essentially distributed in tropical Asia. Only a few species are medicinal, of which *Andrographis paniculata* is the most popular.

*Andrographis paniculata* is distributed in tropical Asian countries, found in a
variety of habitats viz., plains, hill slopes, waste lands, farms, dry or wet lands, sea shore and even road sides. Native populations of *Andrographis paniculata* are spread throughout South India and Sri Lanka; represent the centre of origin and diversity of the species (Hooker, 1885; Bhat and Nanavati, 1978). The herb is also available in northern stations of India, Java, Malaysia, Indonesia, West Indies and elsewhere in America from where it was introduced (Hooker, 1885; Ridley, 1967; Backer and Brink Jr., 1967; Correll and Correll, 1982). Unlike other species of the genus, *Andrographis paniculata* is of common occurrence in most of the places in our country including the plains and hilly areas up to 500 m. Since time immemorial, village and ethnic communities in India have been using this herb for treating a variety of ailments. It grows erect to a height of 30-110 cm in moist shady places with glabrous leaves and white flowers with rose-purple spots on the petals. *Andrographis paniculata* is also used as a wonder drug in traditional Siddha and Ayurvedic systems of medicine as well as in tribal medicine in India and for multiple clinical applications in some other countries. The therapeutic value of kalmegh is due to its mechanism of action (enzyme induction). The plant extract exhibits anti-typhoid and anti-fungal activities (Anon., 1985). Kalmegh is also reported to possess anti-hepatotoxic, anti-biotic, anti-malarial, anti-hepatitic, anti-thrombogenic, anti-inflammatory, anti-snake venom, and anti-pyretic properties, besides its general use as an immunostimulant agent. Andrographolide, chief constituent extracted from the leaves of the plant, is reported to have anti-HIV activity (Calabrese et al., 2000). Andrographolide is also attributed with such other activities like liver protection under various experimental conditions of treatment with galactosamine (Saraswat et al., 1995), paracetamol (Visen et al., 1993) etc. Despite its enormous medicinal and economic importance, attempts to cultivate *Andrographis paniculata* have seldom been undertaken; hence local vaidyas as well as drug companies depend on its wild sources for the supply of raw material. Cultivation experiments were also reported by various authors from different parts of South East Asia (Zhou, 1987; Ramesh et al., 1997; Alagesaboopathi and Balu, 1997; Nandi, 1992; Muniramappa et al., 1997).
Commercial cultivation of medicinal crop species through seeds generally exhibit late, erratic and poor germination (Gupta et al., 1993) with substantial loss in seed viability. The major problem in the cultivation of ashwagandha and kalmegh is the poor germination percentage and establishment at field level. The quality of seed determines the potential for its field emergence, yield and its storability. The seed germination is the first and foremost step in seed quality assurance and optimizing yields of a given seed lot. Physical purity is the second most important seed quality parameter. It will help in regulating the seed quality in open market to end users. To assess the genetic purity among of the seed accessions, the seed and morphological characters at different stages of crop growth are being investigated. The seed moisture test is used during all steps of any successful seed programme. It is used to predict optimum crop harvest time in the field, to prevent mechanical damage during drying and seed processing, and to predict the seed longevity during seed storage. Additionally, it is used for seed certification purposes. Seed health is another important component of seed quality parameter; since seed is an important exchange material for farming, seed production and research at national and international level. The danger of introducing pests and pathogens come along with seed exchange. These hazards may accompany, adhere to or remain inside the exchange material. Health of the seed refers to the presence or absence of disease causing organisms, such as fungi, bacteria, viruses and animal pests, including nematodes and insects. Seed health test results suggest the necessity to perform seed lot treatment in order to eradicate seed-borne pathogens or reduce the risk of disease transmission.

Seed testing protocols in some medicinal crop plants are available; further International Seed Testing Association (ISTA) has been recommending and prescribing the seed testing protocols (i.e., requirements of temperature and substratum regularly). The information on requirement of temperature and substrate for seed germination in ashwagandha was neither available in ISTA rules (Anon., 2008) nor any systematic study has been reported. Some fragmented information on seed germination in ashwagandha is available in literature (Vakeswaran and Krishnasamy, 2003) needs validation. In order to
encourage the successful commercial cultivation of ashwagandha by seeds, standardization of germination testing procedure is essential as suggested for some other medicinal crops (Parihar et al., 2005a).

Physiological maturity and harvesting time are the major considerations in the production of quality seeds. Seed maturation refers to morphological, physiological and functional changes in seeds that occur from the time of fertilization until the seeds are ready for harvest. Close association between fruit maturation and seed maturation has been reported in some legume crops like cowpea (Manohar and Mathur, 1975) and blackgram (Rao et al., 1978). At physiological maturity, the seed quality attributes are at their optimal level. Flowering, seed development and maturation have impact on seed quality attributes like seed size, colour, germination, vigour and ultimately cultivation. Seed moisture content at different harvest times influences the hard seededness in some of the leguminous species (Argel and Humphrey, 1983). No systematic studies on morphological indices of seed physiological maturity have been reported in ashwagandha. Hence, the present study was undertaken. Seed dormancy is common in wild species and land races but less common in cultivated species (Gao and Yamata, 1991). Ashwagandha itself has been extensively domesticated from the wild form. In India, at least five different cultivars have been developed, adapted to different climates. Presence of seed dormancy for a short period after maturity is beneficial in arresting seed germination within a fruit and also for adaptation in wild. However long-period of seed dormancy poses problem in cultivating a species, when immediate sowing and/or seed testing is required. Since some pre-sowing treatments are reported to be effective in optimizing germination in seeds of various medicinal plant species (Butola and Badola, 2004; Kattimani and Reddy, 1999). Therefore, application of pre-sowing treatments (both physical and chemical) also needs to be investigated. Since agriculture began, farmers have had to maintain viable seeds to maintain stock for several years. Therefore storage behaviour of ashwagandha was also investigated. Information on propagation procedures, germination requirements, seed development and maturation, seed dormancy and its
management, seed storage behaviour and other related seed quality parameters of medicinal plants is very meagre (Parihar and Kumar, 2006).

Cultivation techniques will be investigated in both the chosen experimental systems (ashwagandha and kalmegh), whereas, the other related parameters will be investigated in one experimental system (ashwagandha) in view of its great export value and demand, to meet the increasing demand cultivation technology needs to be standardized. Each part of ashwagandha has been consumed in various herbal preparations.