C. Chattopadhyay and D. Prasad (eds),
Dynamics of Crop Protection and Climate Change

Hortipasture Ecosystem: Diseases and Management Strategies under Climate Change Scenario in Semi-arid Condition

11

H. V. Singh, Ritu Mawar, Sunil Kumar and R.V. Kumar

Arid and semi-arid or subhumid zones are characterized by low erratic rainfall of up to 700 mm per annum, periodic droughts and different associations of vegetative cover and soils. In the semi-arid zones, inter annual rainfall varies from 20-50% with averages of up to 700 mm, and in this areas, agricultural harvests are likely to be irregular, although grazing is satisfactory (Goodin and Northington 1985). Semi-arid area is also prone to climate change and considerable increase in the area due to climates was observed in the states of Madhya Pradesh, Bihar and Uttar Pradesh of India (Rao *et al.* 2013). Arid and semi-arid regions are characterized by a climate with no or insufficient rainfall to sustain agricultural production. Within India, almost 53.4% land area comprises arid and semi-arid regions (First NATCOM, GoI 2004) as depicted in Fig 11.1. In these regions, cultivation is restricted to more productive but limited land, while a large animal population depends on native vegetation. The rains are erratic and often come in a few heavy storms of short duration resulting in high run-off, instead of replenishing the ground water. Undulated land topography, stony and gravelled soil enhances run off and cause of ground water scarcity. Protective vegetation cover is sparse and there is very little moisture for the most parts of the year. Climate change is further aggravating the existing problems. In terms of being prone to drought, however, the semi-arid region extends to a larger area. In fact, 99 districts, most of them large in size, across 14 states are declared as drought-prone districts. Over 75% of the cropped area (*i.e.* 131 million ha out of 174 million ha) is in the semi-arid tropics in the country. About 265 million people in the rural areas are severely affected in most of these drought-prone districts of India. Low and erratic rainfall coupled with extreme temperatures and intense solar radiation makes these regions the most vulnerable regions in India.

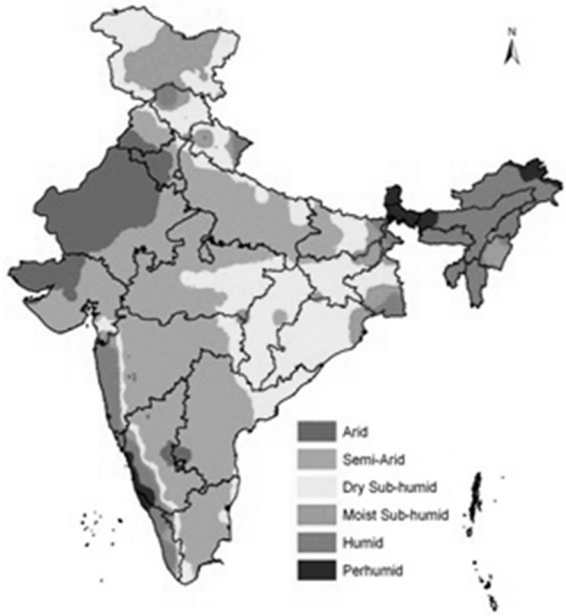

Figure 11.1. Semi-arid Areas in India during 1991-2004. For Color Reference, See Page 392.
Source: ICRISAT, SASA 2012

Climate change is one of the major challenges in 21st century faced by agriculture in India, especially in the Semi-Arid Tropics (SAT) of the country. In recent years, natural and anthropogenic factors have impacted climate variability and contributed to a large extent to climate change. Increased semi-arid area by 8.45 M ha in five states, viz., Madhya Pradesh, Bihar, Uttar Pradesh, Karnataka and Punjab, and decreased semi-arid area by 5 M ha in eleven states, contributed to overall increase in SAT area of 3.45 M ha in the country. Overall, there has been a net reduction of 10.71 M ha in the dry sub-humid area in the country (Rao *et al*. 2013).

India ranks first among the countries that practice rain-fed agriculture both in terms of extent and value of production. Out of an estimated 140.3 m ha net cultivated area, 79.44 M ha (57%) is rainfed, contributing 44% of the total Food grain production. In the rain-fed areas, farmers' dependence on livestock, besides arable farming, as an alternative source of income is high. It is estimated that nearly two out of three heads of cattle population in India thrive in rain-fed regions.

Status of Semi-arid Region of India

Rainfed agriculture, predominant in arid and semi-arid region, is being adversely affected by four-fold problems of land degradation, slow climatic change,

Few Pages are not available

should be standardized for enriching the myco-rhizosphere with an aim to develop survival capacity and vigor in saplings/root slips against biotic and abiotic stresses.

References

Askary, M. A., R. Mostajeran, Amooaghaei and M. Mostajeran 2009. "Influence of Co-inoculation *Azospirillum brasilense* and *Rhizobium melilotiplus* 2, 4-D on Grain Yield and N, P, K Content of *Triticum aestivum* (Cv. Baccros and Mahdavi)." *American-Eurasian Journal of Agricultural & Environmental Sciences*, 5(3): 96-307.

Babana, A.H. and H. Antoun. 2006. "Effect of Phosphate Rock-Solubilizing Microorganisms on Phosphorous Uptake and Yield of Field Grown wheat Triticumaestivum L. in Mali." *Plant and Soil*, 287: 51-58.

Boxall, A., A. Hardy, S. Beulke, T. Boucard, L. Burgin, P.D. Falloon, P.M. Haygarth, T. Hutchinson, R. Sari Kovats, G. Leonardi, L.S. Levy, G. Nichols, S.A. Parsons, L. Potts, D. Stone, E. Topp, D.B. Turley, K. Walsh, E.M.H. Wellington and R.J. Williams. 2009. "Impacts of Climate Change on Indirect Human Exposure to Pathogens and Chemicals from Agriculture." *Environmental Health Perspectives*, 117 (4): 508–514.

Chabot, R., H. Antoun, J.W. Kloepper and C.J. Beauchamp. 1996. "Root Colonization of Maize and Lettuce by Bioluminescent Phosphate-solubilizing *Rhizobiumlegu-minosarumbio* var *phaseoli*." *Applied and Environmental Microbiology*, 62: 2767-2772.

Chakraborty, S. and A. Newton. 2011. "Climate Change, Plant Diseases and Food Security: An Overview." *Plant Pathology*, 60: 2–14.

Garrett, K. A., M. Nita, E.D. DeWolf, L. Gomez and A.H. Sparks. 2009. "Plant Pathogens as Indicators of Climate Change", in T. Letcher (ed.), *Climate Change: Observed Impacts on Planet Earth*. Dordrecht: Elsevier.

Goodin, J.R. and D. K. Northington. 1985. *Plant Resources of Arid and Semiarid Lands: A Global Perspective*. Orlando, Florida: Academic Press.

Gregory, P.J., J.S.I. Ingram, B. Campbell, J. Goudriaan, L.A. Hunt, J.J. Landsberg, S. Linder, M. Stafford Smith, R.W. Sutherst and C. Valentin. 1999. "Managed Production Systems", in B. Walker, W. Steffen, J. Canadell and J.S.I. Ingram (eds), *The Terrestrial Biosphere and Global Change: Implications for Natural and Managed Systems*, pp. 229–270. Cambridge: Cambridge University Press,

Grulke, N. E. 2011. "The Nexus of Host and Pathogen Phenology: Understanding the Disease Triangle with Climate Change." *New Phytologists*, 189: 8-11.

Hannukkala, A.O., T. Kaukoranta, A. Lehtinen and A. Rahkonen. 2007. "Late-blight Epidemics on Potato in Finland, 1933–2002; Increased and Earlier Occurrence of Epidemics Associated with Climate Change and Lack of Rotation." *Plant Pathology*, 56: 167– 76.

Harman, G.E., C.R. Howell, A. Viterbo, I. Chet and M. Lorito. 2004. "*Trichoderma*

Species--Opportunistic, Avirulent Plant Symbionts." *Nature Reviews Microbiology,* 2: 43-56.

Heitefuss, R. 1989. *Crop and Plant Protection: the Practical Foundations*. New York: Halsted Press.

India first National Communication to UNFCCC. 2004. MoEF, Government of India.

Intergovernmental Panel on Climate Change, Climate Change. 2007. *The Fourth IPCC Assessment Report*. Cambridge, UK: Cambridge University Press.

Kang, S. H., H.S. Cho, H. Cheong, C.M. Ryu, J.F. Kim and S.H. Park. 2007. "Two Bacterial Endophytes Eliciting Both Plant Growth Promotion and Plant Defense on Pepper (*Capsicum annuum* L.)." *Journal of Microbiology and Biotechnology,* 17: 96–103.

Kleifeld, O. and I. Chet. 1992. "*Trichoderma harzianum* interaction with plants and effects on growth response." *Plant and Soil,* 144: 267-272.

Kumar, S. 2013. "Plant Disease Management under Changing Climatic Scenario." *Indian Journal of Mycology and Plant Pathology,* 42(2): 149-154.

———. 2014. "Plant Disease Management in India: Advances and Challenges." *African Journal of Agricultural Research,* 9(15): 1207-1217.

Kumar, S. and O. Gupta. 2012. "Expanding Dimensions of Plant Pathology." *JNKVV Research Journal,* 46(3): 286-293.

Kumar, S. and S. Kumar. 2001. "Fruit Trees for Sustainable Agriculture through Hortipastoral System in Semi-Arid Environment." *Range Management and Agroforestry*, 22(1): 33-42

Legreve, A. and E. Duveiller. 2010. "Preventing Potential Disease and Pest Epidemics under a Climate Change", in M.P. Reynolds (ed.), *Climate Change and Crop Production*. Oxfordshire, UK: CABI.

Mahmuti, M., J.S. West, J. Watts, P. Gladders and B.D.L. Fitt. 2009. "Controlling Crop Disease Contributes to Both Food Security and Climate Change Mitigation." *International Journal of Agricultural Sustainability*, 7: 189-202.

Melloy, P., G. Hollaway, J. Luck, R. Norton, E. Aitken and S. Chakraborty. 2010. "Production and Fitness of *Fusarium pseudograminearum* Inoculum at Elevated Carbon Dioxide in FACE." *Global Change Biology,* 16: 3363–73.

Oerke, E. C. 2006. "Crop Losses to Pests." *Journal of Agricultural Science*, 144: 31–43.

Ortiz, R., K.D. Sayre, B. Govaerts, R. Gupta, G.V. Subbarao, T. Ban and M. Reynolds. 2008. "Climate Change: Can wheat beat the heat?" *Agriculture, Ecosystems and Environment,* 126(1): 46-58.

Pathak, P.S. and M.M. Roy. 1994. *Silvipasture System of Production*. Jhansi: IGFRI Bulletin.

Raimam, M.P., U. Albino, M.F. Cruz, G.M. Lovato, F. Spago, T.P. Ferracin, D.S. Lima, T. Goulart, C.M. Bernardi, M. MIYauchi, M.A. Nogueira and G. Andrade. 2007. "Interaction among Free-living N-fixing Bacteriaisolated from *Droseravillosa* var.

Villosa and AM Fungi (*Glomusclarum*) in Rice (*Oryza sativa*)." *Applied Soil Ecology,* 35: 25-34,

Rao, A.V.R.K., S.P. Wani, K.K. Singh, M.I. Ahmed, K. Srinivas, S.D. Bairagi and O. Ramadevi. 2013. "Increased Arid and Semi-Arid Areas in India with Associated Shifts during 1971-2004". *Journal of Agrometeorology,* 15(1): 11-18.

Requena, N., I. Jimenez, M. Toro and J.M. Barea. 1997. "Interactions between Plant-growth-promoting Rhizobacteria (PGPR), Arbuscular Mycorrhizal Fungi and Rhizobium spp. in the Rhizosphere of Anthylliscytisoides, a Model Legume for Revegetation Inmediterranean Semi-Arid Ecosystems." *New Phytologist,* 136: 667–677.

Robinet, C., N. Van Opstal, R. Baker and A. Roques. 2011. "Applying a Spread Model to Identify the Entry Points from which the Pine Wood Nematode, the Vector of Pine Wilt Disease, would spread most rapidly across *Europe." Biological Invasions*, 13: 2981-2995.

Ruiz-Sánchez, M., E. Armada, Y. Muñoz, I.E.G. de Salamone, R. Aroca, J.M. Ruiz-Lozano and R. Azcon. 2011. "*Azospirillum*and arbuscularmycorrhizal colonization enhanced rice growth and physiologicaltraits under well-watered and drought conditions." *Journal of Plant Physiology,* 168: 1031–1037.

Strand, J. F. 2000. "Some Agrometeorological Aspects of Pest and Disease Management for the 21st Century." *Agricultural and Forest Meteorology,* 103: 73–82.

Thind, T. S. 2012. "Fungicides in Crop Health Security." *Indian Phytopathology,* 65(2): 109–115.

Van Maanen A. and X.M. 2003. "Modelling Plant Disease Epidemics." *European Plant Pathology*, 109: 669-682

Venkateswarulu, B. 2005. *Rainfed Agro-Ecosystem Production System Research Completion Report*, National Agricultural Technology Project, Agro-eco system directorate (Rainfed). Hyderabad: Central Research Institute for Dryland Agriculture.