CHAPTER 1

GENERAL INTRODUCTION

The potato is one of mankind's most valuable food crops. In volume of production (347 million metric tons annually) it ranks fourth in the world after maize, rice and wheat, with an estimated production area of 18.9 million hectare (FAOSTAT data, 2004). Among root crops potato ranks first in volume produced and consumed, followed by cassava, sweet potato, and yam (FAOSTAT data, 2004).

The relatively high carbohydrate and low fat content of the potato makes it an excellent energy source for human consumption (Dean, 1994). The tuber is known to supply carbohydrate, high quality protein, and a substantial amount of essential vitamins, minerals, and trace elements (Horton & Sawyer, 1985). Moreover, the potato crop provides more nutritious food per unit land area, in less time, and often under more adverse conditions than other food crops. It is said to be one of the most efficient crops in converting natural resources, labour and capital into a high quality food with wide consumer acceptance (Horton, 1980).

The cultivated potato belongs to the family Solanaceae, genus *Solanum,* and section Tuberarium (Correll, 1962). The potato has its origin in the high Andes of South America and was first cultivated in the vicinity of Lake Titicaca near the present border of Peru and Bolivia (Horton, 1987). It was introduced to Ethiopia in 1858 by the German botanist Schimper (Pankhurst, 1964). Since then, the potato has become an important crop in many parts of the country.

Ethiopia, with an area of about 1.1 million square km and a total population of 67.7 million, is the fourth largest country in Africa, and is located within 3-15^{o}N latitude and 33-48^{o}E longitude. Agriculture is the mainstay of the economy and accounts for half of the gross domestic product, 85% of export earnings, and more than 80% of the total employment (http://www.nationmaster.com/country/et/Economy). The climate of Ethiopia is tropical monsoon with large topographic-induced variations. Based on temperature and moistures regimes the country has been classified into 18 major and 49 sub agro-ecological zones (Figure1.1). About 65% of the land area is situated in moist, sub-humid, humid and per-humid agro-ecologies. The remaining 35% is semi-arid with high temperatures throughout the year (EARO/ARTP, 1999). Although approximately two-thirds of the country is arable, only 15% of the area is presently under cultivation, and about 3% of the 3.5 million hectares of potentially irrigable land is being irrigated (http://www.madeinethiopia.net).

Ethiopia has suitable edaphic and climatic conditions for the production of high quality ware and seed potatoes. About 70% of the available agricultural land is located at an altitude of 1800-2500 m.a.s.l and receives an annual rainfall of more than 600 mm, which is suitable for potato production (Solomon, 1987). However, the current total area under potato production is estimated at 36, 736 ha with an annual production of 385, 258 metric tons. The national average yield is approximately 10.5 tons/ha, which is very low compared to the world average of 16.4 tons/ha (FAOSTAT data, 2004). A number of production problems that account for the small area cropped with potato and the low national yield have been identified. The major ones are the concentration of potato cultivation in the highlands with very little in the lowlands, lack of well-adapted cultivars, unavailability and high cost of seed tubers, non optimal agronomic practices, the prevalence of diseases and insect pests, and inadequate storage, transportation, and marketing facilities.

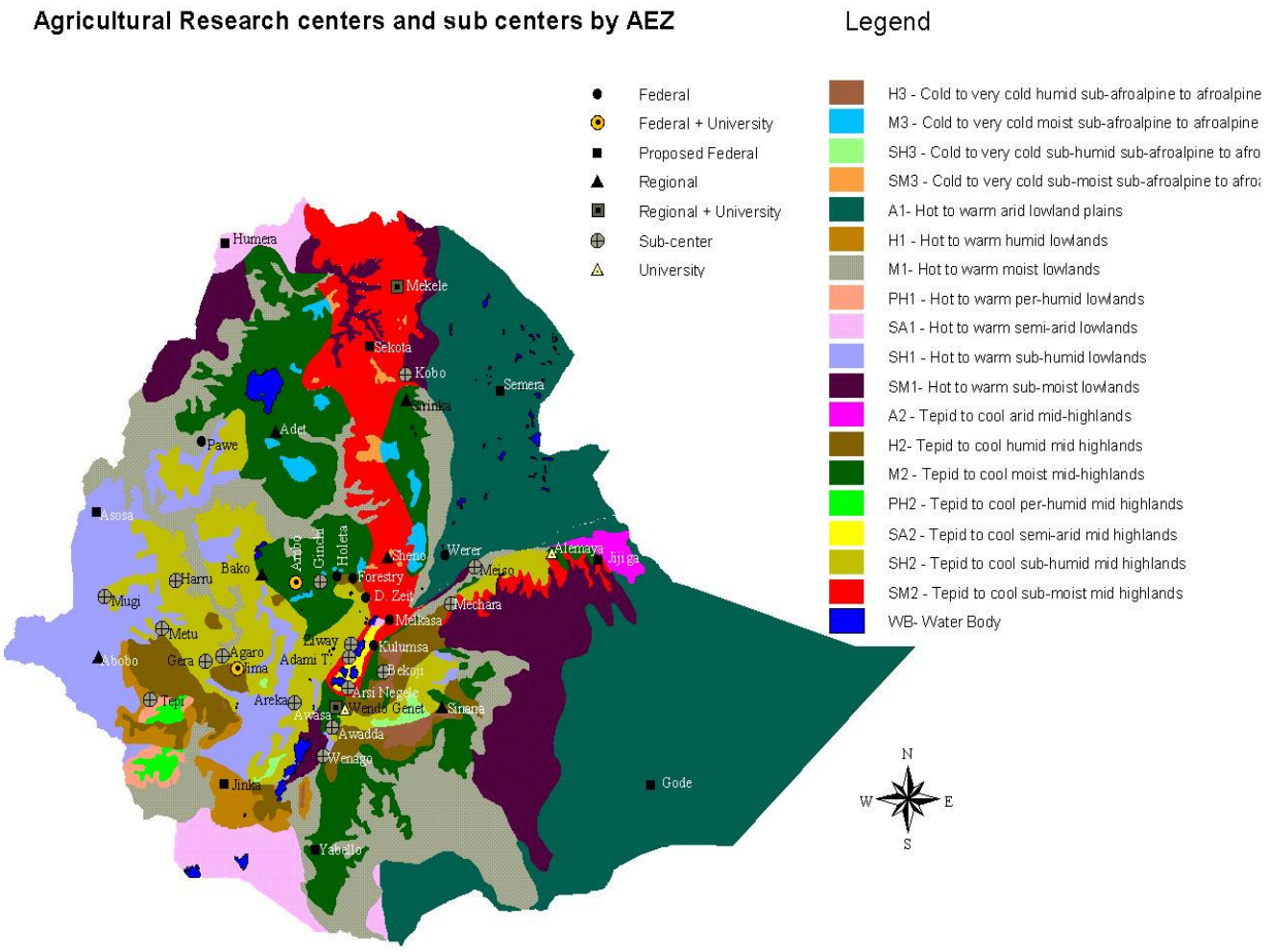

Figure 1.1. The major and sub agro-ecological zones of Ethiopia (EARO/ARTP, 1999)

Potato is exported to Djibouti and Somalia from the highlands of the eastern part of the country. There is a high demand and attractive prices for quality ware potatoes. Despite this great potential further expansion has been restricted due to the shortage of land as the highlands of the region are densely populated (land holding approximately 0.25 ha per farmer) and the majority of the land is used for cereals such as sorghum and maize production.

Among other environmental conditions, temperature and photoperiod are known to affect the various physiological processes of the potato plant. In general, potato prefers a cool climate for growth and development. Optimum temperatures for foliage growth and net photosynthesis are 15-25 ^{o}C, and 20 ^{o}C for tuberization. When the temperature is above 29 ^{o}C tuberization is inhibited, foliage growth is promoted and net photosynthesis and assimilate partitioning to the tubers are reduced (Gawronska *et al*., 1992; Hammes & De Jager, 1990; Levy, 1992; Menzel, 1980). The potato crop is a remarkable adaptable crop and with the development of modern cultivars and appropriate technologies, its production is being expanded in different parts of the world. However, its production in the hot tropical climates, i.e. regions with an altitude up to 1000 m, day length of approximately 12 h, minimum night temperature of 19-20 ºC, and maximum day temperature as high as 40 ºC (Accatino, 1981, as quoted by Ewing & Keller, 1983), has been restricted due to unfavourably high temperatures. Both soil and air temperatures are important in influencing the growth of the potato (Haverkort, 1978; Ewing & Keller, 1983). In Ethiopia about 35% of the available agricultural land is located in the semiarid region of the country where potato production has not been practiced due to unfavourably high temperatures throughout the year (EARO/ARTP, 1999).

The negative effect of high temperatures on tuber formation is believed to mediated through the production of high levels of endogenous gibberellins (GA) (Menzel, 1983) that is known to delay or inhibit tuberization (Abdella *et al*., 1995; Vreugdenhil & Sergeeva, 1999). The hormonal balance controlling potato tuberization can be altered using paclobutrazol (Simko, 1994). PBZ is a triazole plant growth regulator known to inhibit GA biosynthesis and abscisic acid (ABA) catabolism through its interference with *ent*-kaurene oxidase activity in the *ent*-kaurene oxidation pathway (Rademacher, 1997).

To develop adaptable cultivars for the eastern parts of Ethiopia, the Potato Improvement Program of Alemaya University has been introducing potato germplasm from the International Potato Centre. Most of the genotypes bloom profusely and some of them set berries under the growing conditions of the highlands of Eastern Ethiopia. Information regarding the effect of flowering and berry set on growth, tuber yield and quality of potato is scanty.

Limitations to potato production include the tendency towards excessive vegetative growth instead of tuber growth in the lowlands, and profuse flowering and fruit formation in some of the promising cultivars in the highlands. If potato production can be expanded to the warm lowland areas of Ethiopia it can contribute significantly towards nutritional self-sufficiency in the production of food crops. Hence, the main objectives of the study were:

1. To investigate the response of potato grown under non-inductive greenhouse conditions to paclobutrazol so as to generate information for further field trials.
2. To investigate the responses of potato grown in the hot tropical lowlands of Eastern Ethiopia to paclobutrazol as a possible intervention to introduce potato culture to these marginal areas.
3. To investigate the effects of cultivar and flower and fruit development on the growth, tuber yield and quality of potato, and to devise chemical control measures to prevent berry set.