Potential yield of peanuts in north-eastern Australia

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Summary We present a technique for analysing the yield potential of peanuts across north-eastern Australia under conditions where water is non-limiting. The technique uses a peanut simulation model (QNUT) in conjunction with long-term daily temperature and radiation records. Effects on potential yield other than from climate (e.g. soil) are not considered. Point data obtained from the model are spatially extrapolated to produce maps showing the yield potential at three distinct levels of production risk. The analysis shows that the highest median yield potential for a I December sowing can be expected for an area ranging from northern NSW to central Queensland.

Introduction

The market potential for Australian peanuts is promising. Overseas imports currently supplement Australian production to ensure a continuous supply to local markets. Due to insufficient domestic production, existing market niches have so far not been exploited. Growing peanuts could provide producers with increased returns, improve Australia's balance of trade and contribute to achieving more sustainable farming systems. The peanut industry is therefore revising management strategies and is expanding into new production areas (7). To aid the industry in this process, it is important to quantify impact of such changes and the productive potential of these new areas.

New production and harvest technologies make it feasible to produce peanuts in areas previously not considered suitable. Queensland's coastal areas, for instance, have long been considered as too humid for economic production. However, as recent experience in the Bundaberg region showed, excellent crops can be produced under those climatic conditions. Residual benefits of a peanut crop on the following crop can also be substantial either in form of additional nitrogen fixed by the legume or as a sanitation crop in continuous crop rotations. This is evident in some sugar cane crops grown in Bundaberg after peanuts (Hatfield, pers. comm.).

In the past, many experiments have been conducted to answer specific problems for peanut producers (e.g. 1,2). The results of these experiments have been used in developing and validating the dynamic peanut simulation model QNUT (3). When tested against independent data from a range of locations QNUT predicted total dry matter adequately. Pod yields were predicted well for Australian locations (RMSD = 61 g/m2), but overpredicted for Indonesia (3). Using QNUT in conjunction with long-term, daily climate records obtained from 38 climate stations throughout Queensland and NSW, this paper outlines a technique for comparing and quantifying yield potential of peanut crops in north-eastern Australia.

Methods

To simulate development and yield of peanut crops adequately, it is important to use high quality environmental data. Most crop simulation models require at least daily values of temperature. radiation and rainfall. Long-term records of these values arc needed to reflect adequately the high climatic variability encountered in Australia (5). Rainfall records have been collected at many sites and a reasonably dense network of stations with daily rainfall records exists. However, potential yield (i.e. yield in the absence of water stress) is determined by temperature and incident solar radiation. These data are more difficult to obtain and much effort has been spent recently on the development of a network of complete climate files (Meinke, unpublished data). We already have 39 climate files, ranging from Wagga Wagga in southern NSW to Cairns in north Queensland.

We used QNUT (3), with each of these 39 climate files to conduct long-term simulations under non-limiting water conditions. The files differed in length and ranged from 18 years at Lansdown to 101 years at Dalby. At each location, *the* long-term simulation results were used to calculate the respective 20, 50 and 80 percentile yield levels. A 20 percentile yield level is equivelent to a 20% production risk. i.e. yields at this level will be exceeded in 80% of years.

A December I sowing date for a Virginia Bunch type cultivar was assumed. This sowing date was chosen to illustrate the technique since peanuts sown at this time are not affected by either early or late frosts at any of the locations. Effects of soil type on yield potential, or on the practicalities of peanut production generally, were not considered.

To quantify peanut yield potential across north-eastern Australia we mapped these percentile values with a simple geographic information system (4). Using extrapolation routines, the point data obtained from each climate file were converted into yield isolines. The locations of the climate stations are indicated on the maps. The interpolation scheme used is a combination of Laplacian and spline interpolation and interpolates a set of arbitrarily spaced data points onto a rectangular grid. Thus, caution is warranted when interpreting areas not well covered by actual simulation points such as coastal NSW and areas in northern Queensland outside the Atherton Tablelands.

Results

Yield potential at the 20, 50 and 80% production risk levels are given in Fig. I. The median yields (i.e. 50% production risk) across all locations clearly show a high potential for central Queensland and some parts of northern NSW. The area with a potential of 6 t/ha or more is roughly defined by a line drawn through the following locations: Mackay, Clermont, Charleville, Walgett. Narrabri, Goondiwindi, Kingaroy and Bundaberg. Median yield potentials of most of central NSW and some parts of southern Queensland. at the 50% risk level, are generally between 5 and 6 t/ha.

At the 20% risk level high yield potentials (> 6 t/ha) are restricted to an area roughly defined by the triangle Rockhampton - Theodore - Bundaberg. Between 5 and 6 t/ha can be expected for a band stretching from southern NSW (Parkes) through central NSW (Moree) and on through central Queensland (Mackay). Lower yield potential (< 5 t/ha) can be expected west of latitude 149^0 and south of the 33rd parallel.

At the 80% risk level very high yields (> 7 t/ha) are feasible for a region around St. George. Roma. Theodore and Emerald as well as for the coastal areas of central Queensland (Rockhampton and Bundaberg). At this risk level most of the other areas under consideration fall into the 5 to 7 t/ha category.

Discussion

The results show that, provided adequate soil types for peanut production can be identified, there could be considerable scope for industry expansion. Irrigation areas in northern NSW, southern Queensland and central Queensland seem particularly promising. Other areas such as central and southern NSW might also be considered for production, but a more detailed analysis of potential frost risks is needed. This is particularly important when considering planting dates other than I December. Generally. these findings correspond with outcomes from test crops grown successfully in central Queensland, around Emerald and near Bundaberg, as well as in some areas of NSW (Hatfield. pers. comm: Box. pers. Comm).

In our analyses potential yield variations are entirely caused by variations in temperature and solar radiation and their interactions. In southern regions low night temperatures can adversely affect crop development (2) negating the positive effects of high solar radiation levels. In the tropics high temperatures increase developmental rates thus shortening the growing period. This is coupled with lower solar radiation levels caused by cloudiness during the wet season and shorter days during summer (3). A favourable balance between temperature and radiation levels seems to prevail in regions showing high yield potential.

Potential harvest losses due to excessive rainfall during the harvest period also need to be quantified. A suitable technique to examine this issue was developed for Kingaroy (6) and is presently being applied to the whole of north-eastern Australia.

This analysis gives an example of the technique. Other sowing dates and yield potential of dryland crops need to be investigated similarly. This approach indicates likely yield levels in the absence of soil, pest and disease constraints and in the absence of climatic hazards, such as frost and excessive rain at harvest. An analysis of these constraining factors needs to be considered in conjunction with the yield potential information when considering growing peanuts at a new location.

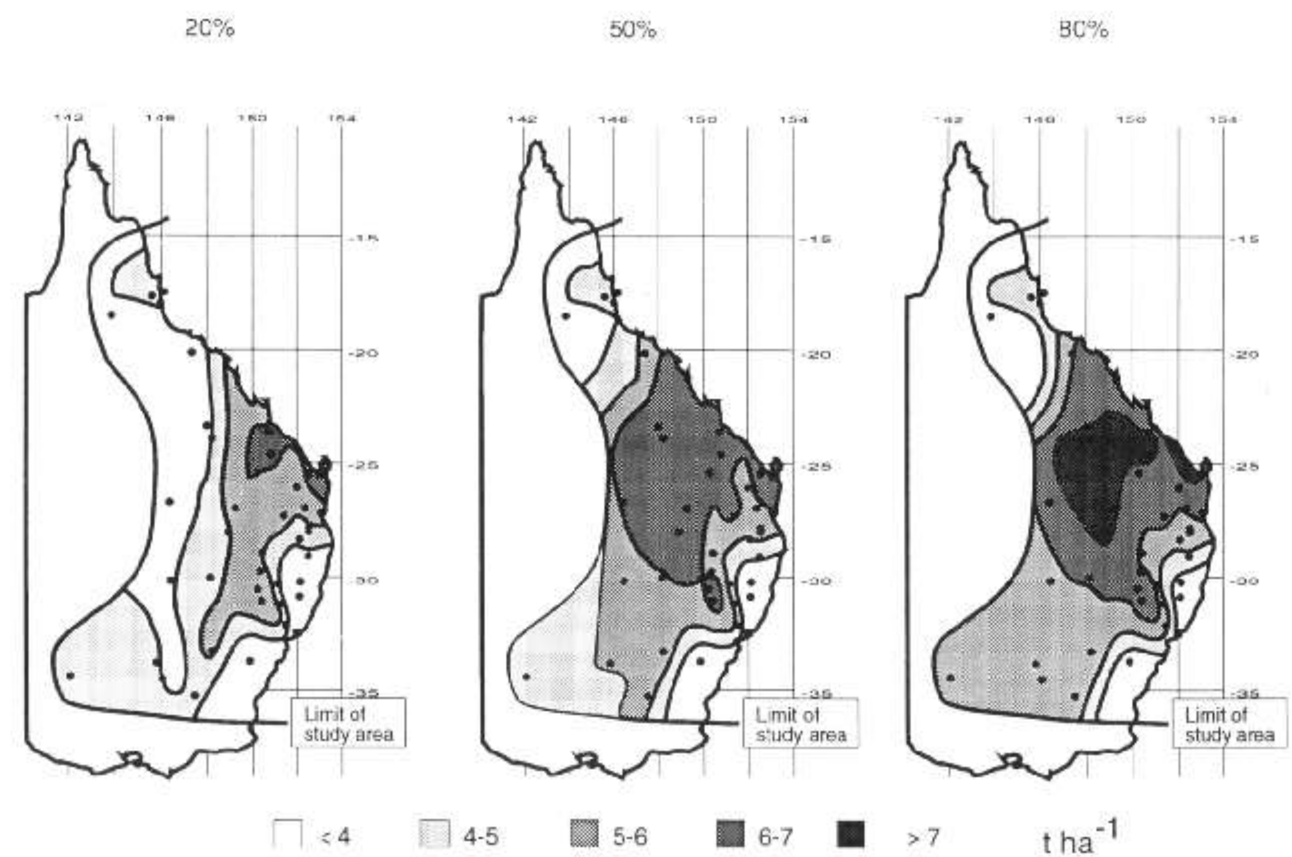

Figure 1 : Peanut yield potential for a 1 December sowing at the 20, 50 and 80% production risk level. Circles denote the locations of climate stations for which simulations were conducted.

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