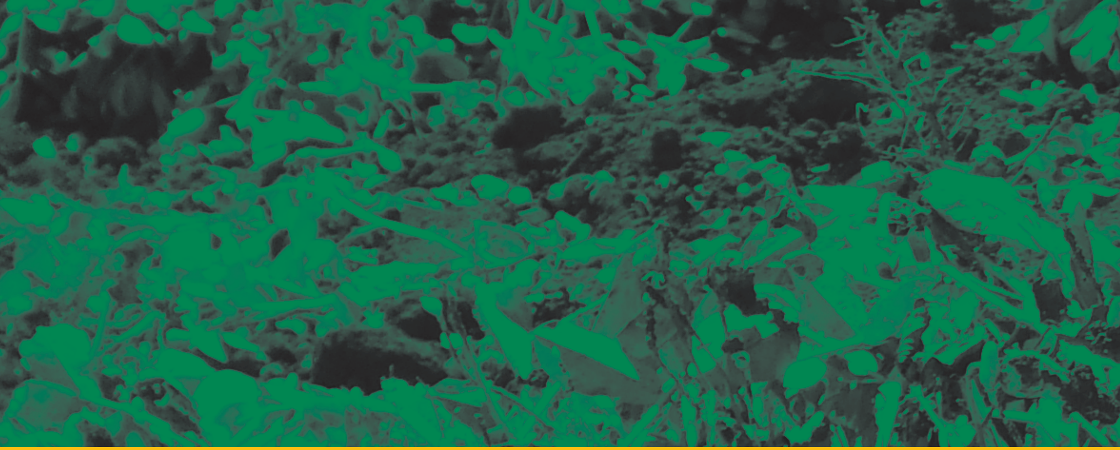

NORTHERN

OCTOBER 2017

GRDC GROWNOTES™

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

PEANUTS

SECTION 1

PLANNING/PADDOCK PREPARATION

PEANUT PRODUCTION SEASON PLAN | PADDOCK SELECTION | PADDOCK HISTORY | BENEFITS OF PEANUTS AS A ROTATION CROP | DISADVANTAGES OF PEANUTS AS A ROTATION CROP | PRE-PLANT WEED CONTROL | POTENTIAL CROP CONTAMINANTS | SEEDBED REQUIREMENTS | SOIL MOISTURE | YIELD AND TARGETS | DISEASE STATUS OF PADDOCK | INSECT STATUS OF PADDOCK

Planning/Paddock preparation

1.1.1 Peanut production season plan

A crop management table is a valuable tool for planning the peanut cropping season (Figure 1).

Crop stage-weeks			0	2	4	6	8	10	12	14	16	18	20	22
Ground preparation	Deep ripping													
Fertiliser	Soil test	Lime and/ or pre-plant fertiliser			Gypsum									
Planting			Plant											
Weed control		Pre-plant incorporated	Pre-emergent	Post-emergent applications										
Foliar disease control					Regular scheduled applications of foliar fungicides for leafspot, rust, net blotch									
Sclerotinia control														
Irrigation requirement			HIGH	LOW		HIGH							MODERATE	
Digging										Digging				
Threshing											Threshing			
Growth stage for a 20 to 22 week variety			Emerge	Vegetative growth										
					Flowering and pegging									
							Pod development							
													Wheeler	
													Middleton	
													Menzies	
													Holt	
										Redvale			Page	

Figure 1: *Peanut crop management table.*

Source: PCA [1]

Use the following checklist to ensure that you complete each of the operations at the correct time.

1 G Wright, L Wieck, P Harden (2015) Peanut production guide, August 2015. Peanut Company of Australia, http://www.pca.com.au/wp-content/uploads/2016/11/PWH-Peanut-Production-Guide-2015.pdf

VIDEOS

Planter calibration

2010 Peanut Planting

Boomspray calibration

Pre-season

- Carry out soil tests and have results interpreted by a qualified agronomist.
- Determine whether a soil ameliorant such as gypsum or lime is required.
- Forecast likely input requirements (pesticides, fungicides, inoculants, seed) and plan procurement.
- Determine your desired planting date based on the seasonal forecast and risk.
- Determine your deadline for planting. If this deadline is reached and it has not rained, pre-water your paddock.
- Plan and budget an irrigation schedule.
- Calculate and plan machinery requirements.
- Calibrate planter and fertiliser equipment and plan for recalibration between paddocks.
- Calibrate boom spray and check nozzles.
- Determine which variety best suits your conditions and order seed.

Ground preparation

- Deep-rip your paddock.
- Prepare an even seedbed to ensure that it has good tilth.
- If soil ameliorants are required, they should be applied 1–3 months before planting.
- If granular magnesium or zinc is required, apply at least 2 weeks before planting.

Week 0: planting

- Ensure good moisture for planting and germination.
- If using peat inoculants, ensure that they are kept in a cool place (Esky or fridge).
- If using dry inoculant, sprinkle some into the planter box. Half-fill the box with seed (gently) and sprinkle some more inoculant over the seed. Fill the box with seed and sprinkle with some more inoculant.
- Seed placement, depth and calibration should be checked at regular intervals during planting.
- Applications of S-metolachlor (Dual®) are recommended as a post-plant pre-emergent herbicide in most situations. Application needs to be finished as soon as possible after planting (1–2 days) prior to seedling emergence.
- In irrigation systems, S-metolachlor needs to be watered in within 10 days of application, although 5 days is preferred to help ensure good crop emergence.
- Irrigation scheduling plan should be in place.

Week 1: cracking

- Cracking describes when the peanuts are just about to emerge. They start to push through the soil and the rows become visible.
- If the soil is dry or there is a hard crust, irrigation at this time can be beneficial to ensure good emergence.
- If weeds have emerged before the peanuts emerge, consider an application of a knockdown herbicide with no residual, such as paraquat.

Weeks 2 and 3: crop establishment

- Crop should be fully emerged.
- Scout for soil insects and foliar insects, especially *Helicoverpa*. Scout for cutworms (*Agrotis* sp.)
- Generally, no irrigation is recommended at this stage. It may be beneficial to stress the crop.

Weeks 4 and 5: flowering

- Flowering has started.

- Spray any weeds with post-emergent herbicides as recommended by your agronomist.
- Do not irrigate when the very first few flowers appear because it will stress the crop, reducing potential yield.
- Apply protective fungicide applications as recommended by your agronomist.
- If required, apply foliar fertilisers, especially copper (on very sandy soils) and zinc.
- If required, apply gypsum at 1–2 t/ha. Consult your agronomist for more information.
- Scout for foliar insects, especially jassids, leafhoppers, mites and *Helicoverpa*.

Weeks 6 and 7: main flowering

- This is the start of the main flowering and the start of the logarithmic (fastest) growth phase when the peanuts begin to grow very rapidly.
- In irrigation systems, irrigation is essential at this stage because it is when the crop's yield potential is set.
- Use your irrigation to try to fill the soil profile. This may involve two waterings in quick succession.
- Scout for foliar insects and foliar disease.
- Spray appropriate fungicide as needed.
- If inter-row cultivation is needed (e.g. hardsetting soil, weeds), it is best performed no later than at this stage.

Weeks 8 and 9: pegging

- Ensure that you follow your irrigation schedule (crop stress during pegging and podset can be detrimental to yield).
- Pull up two or three bushes to check the pegging and development.
- Scout for foliar insects and diseases.
- Spray appropriate fungicide as needed.
- Spray with foliar fertilisers.
- If Sclerotinia blight could be a problem, spray a protectant fungicide at this time.

Weeks 10 and 11: pegging and pod-setting

- Check schedule if growing peanuts under irrigation.
- Pull up some bushes to check development.
- Scout for diseases and insects.
- Make sure harvesting equipment is properly repaired and maintained.

Weeks 12 and 13: canopy closure and pod-setting

- The crop should reach full canopy closure by week 12, and it should now be setting its peak yield potential.
- The crop factor in your irrigation schedule should now increase to 1.0 (this means the crop will lose as much water as an open pan of water placed in the sun and wind).
- Scout for diseases and insects and spray as necessary.
- Spray with foliar fertilisers as required.

Weeks 14 and 15: pod-filling

- Keep the water up to the crop. Check your irrigation schedule.
- Pull up some bushes to check pod development.
- Scout for insects, especially armyworms (*Spodoptera sp.*), which stay at or just below ground level during the day but feed on pegs during the night.
- Scout for disease, especially rust. Look carefully for raised coppery pustules on the back of leaves.

Weeks 16 and 17: pod-filling and early maturity

- Keep the water up to the crop.
- Scout for disease.
- At the end of week 17, check for signs of maturity. Pull up some bushes up to check for maturity.
- Early-maturing varieties may be fully mature by this time in some environments.

Weeks 18 and 19: maturity and digging

- Water use of the crop may start to lessen during this phase, but dig around under some plants and check the moisture status.
- You still need to keep the crop moist to avoid aflatoxin and to help fill out any later setting pods.
- Check for maturity.
- Scout for any signs of disease.

Weeks 20 and 21

- Check maturity using the hull scrape test and double-check any pods you are unsure of by using the shell-out technique.
- Test maturity in the paddock by running some strips with the digger. Check for losses and maturity.
- Make sure the digger is working properly. The elevator chain speed should be slightly faster than the forward speed of the digger.
- Step down from the tractor regularly to check under the windrow for losses. Try to get good inversion.
- If you are dealing with large areas, it may be best to dig initially a portion that you can comfortably harvest with the thresher.

Harvest

- To avoid aflatoxin contamination, peanuts should remain in the windrow for no more than 3 days.
- Ideal moisture content for threshing, to avoid losses and damage to the kernels, is 12–16%.
- Take samples from the windrow and check the moisture content.
- The speed of the pickup head should match the forward speed. This allows the windrow to be picked up without separating or over-running the inverted bushes.
- Check cylinder speeds regularly; they may have to be adjusted as windrow conditions change during the day.

Pre-cleaning

- Pre-clean your peanuts to remove dirt, sticks, weeds and other extraneous matter.
- Pre-cleaning will also remove many loose shell kernels and immature pods and so decrease the risk of aflatoxin contamination.

Curing

- Ensure that peanuts are adequately pre-cleaned.
- Start drying within 3 h of threshing to prevent aflatoxin development.
- Make sure air temperature in the plenum does not exceed 11°C above ambient temperatures (up to a maximum of 35°C).
- Check that the moisture removal rate does not exceed 0.5% per h.
- The relative humidity of the drying air should be 50–65%.
- Regularly check the temperature and relative humidity in the air tunnel.

MORE INFORMATION

PCA. Peanut production season plan—checklist.

VIDEOS

Soils and challenges

- Regularly check the moisture content of the peanuts. [2]

1.2 Paddock selection

1.2.1 Rotations

When choosing paddocks, rotations past and future should be considered. Peanuts preferably should be rotated with a grass or cereal crop [3] to increase sustainability, reduce disease and make the most use of excess nitrogen (N).

A good crop rotation, avoiding a peanut monoculture, will lower disease levels, which can increase dramatically when peanuts follow peanuts. There is some evidence that peanuts following potatoes have a higher risk of contamination with off-flavour volatile compounds. A genus of actinomycete, *Streptomyces*, is known to produce the volatile compounds associated with off-flavour; these bacteria are present in immature and/or decomposing potatoes, which can lead to a high number of actinomycete spores in the soil. Immature potatoes left after harvest can be roughly the same size as mature peanut pods, and are sometimes harvested with the peanuts. *Streptomyces* on these immature potatoes can be transferred to storage bins, along with the potatoes, during harvesting. [4]

1.2.2 Soils

Peanuts require well-drained, friable soils such as sandy loam, silty loams, and friable clay loam. The preferred soil types for growing peanuts are sands, sandy loams and light clay loams. Peanuts will grow on heavier soils, but harvest losses tend to be high in heavy or sticky soils. [5]

The history of all paddocks new to peanut cropping should be considered; there may be a need to test for heavy metals and pesticides prior to planting (see *Pesticide history* below).

In Australia, peanuts have traditionally been grown on the red clay loams (Ferrosols) of the South Burnett and Atherton Tableland. These soils are naturally friable and have a good water-holding capacity. However, peanuts can be grown on a wide range of soils, provided the surface soil (top 15–20 cm) is reasonably friable.

Soils prone to waterlogging should be avoided because peanuts do not tolerate long periods of waterlogging. Planting on raised beds can help to alleviate minor waterlogging problems.

Heavy clay soils or hardsetting soils that break into large clods should be avoided because pods may be torn off the bush at digging. These loose pods cannot be recovered by the harvester. Heavy soil conditions may lead to high levels of extraneous material in the load, which will incur penalties.

Heavy clays may also become non-trafficable for long periods because of wet weather. This can cause harvesting delays and potential yield losses. [6]

1.3 Paddock history

To be successful, peanuts must form part of a sustainable farming system. New paddocks that have never grown peanuts may be able to produce two consecutive peanut crops. However, the best system involves growing peanuts once every 2 or 3 years on the one paddock with a grass or cereal crop as the rotation species. Good

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2 G Wright, L Wieck, P Harden (2015) Peanut production guide, August 2015. Peanut Company of Australia, http://www.pca.com.au/wp-content/uploads/2016/11/PWH-Peanut-Production-Guide-2015.pdf

3 Peanut Company of Australia, http://www.pca.com.au

4 GRDC (2013) Peanut off-flavour. GRDC Fact Sheet, www.grdc.com.au/GRDC-FS-PeanutOffFlavour

5 G Wright, L Wieck, P Harden (2015) Peanut production guide, August 2015. Peanut Company of Australia, http://www.pca.com.au/wp-content/uploads/2016/11/PWH-Peanut-Production-Guide-2015.pdf

6 G Wright, L Wieck, P Harden (2015) Peanut production guide, August 2015. Peanut Company of Australia, http://www.pca.com.au/wp-content/uploads/2016/11/PWH-Peanut-Production-Guide-2015.pdf

rotation crops for peanuts include sugarcane, maize, Rhodes grass (*Chloris gayana*) and sorghum. [7]

Peanut yields are maximised by rotating with other crops over a 3-year period. Peanuts fix N into the soil; however, they also remove other essential nutrients, which need to be replaced to ensure that yield potential is achieved.

Some farmers grow peanuts for two seasons in one paddock and then rotate out to other crops for three to five seasons.

Another reason why growers are encouraged to adopt a regular rotation of crops with peanuts is to avoid build-up of weed, disease and insect problems, which occur under any system of monoculture.

Crops such as potatoes, navy beans or soybeans are not ideal in long-term sustainable rotations with peanuts because they tend to host many of the same pest and disease problems.

1.3.1 Paddock history trials

Between 1983 and 1996, a trial at the Redvale, in the Kingaroy region, examined effects of various crop rotations and ley pastures on peanut productivity and crop value, and on the incidence of known peanut pathogens. On average, peanut crops yielded 25% higher in rotations than in a monoculture, but the quality of harvested pods was unaffected by rotation. There was no additional yield response to rotation breaks longer than a single year, and no additional response to grass leys over alternate crops. Incidence of known peanut pathogens was significantly affected by rotation, but the impact of these pathogens on crop yield was strongly related to in-crop rainfall and resultant seasonal yield potential. Gross returns from peanut crops in a monoculture were $177 per ha lower per tonne of potential yield than in crop rotations. The findings have been used as a basis for optimising rainfed peanut farming systems for long-term viability and sustainability. [8]

The relatively high yield potential of the crop (up to 5 t dry pods/ha in good seasons) and the excellent prices for quality produce (up to $850/t dry pods) have made peanuts very attractive to farm managers. Often, however, this results in the crop being grown too frequently in the crop rotation in an effort to maximise returns, with a consequent increase in soil-borne pathogens and relatively poor crop performance.

Several overseas studies have demonstrated the need for substantial breaks between peanut crops grown in the same field. In Georgia, USA, for example, increasing periods without peanuts from 1 to 3 years resulted in commercial peanut yields 11–25% (dryland) and 7–36% (irrigated) higher than under peanut monoculture. However, studies have also shown that rotations, particularly under irrigation, were often shorter than optimal because the most successful rotation crops (e.g. cereals and grass leys) were generally of much lower economic value. As Australian farmers face increasing economic pressures, peanut producers face similar temptations to shorten the peanut rotation.

The initial study at Redvale compared a peanut monoculture with peanuts grown after 1 or 2 years of cropping maize, or after 1, 2, 3 or 4 years of grass pasture ley (Rhodes grass). Two replicate plots of each treatment were sown in each of three consecutive seasons. The repeated treatment series was used to sample the response across a range of climatic conditions. In the initial peanut crop after the rotation breaks, plots were split with treatments of either 0 or 4 kg carbofuran/ha to quantify the role of nematodes (*Pratylenchus brachyurus*, root-lesion nematode; and *Meloidogyne hapla*, root-knot nematode) in crop productivity responses. Soil was conventionally tilled prior to sowing each crop and basal nutrients (N, phosphorus, potassium) were applied to meet crop requirements.

7 G Wright, L Wieck, P Harden (2015) Peanut production guide, August 2015. Peanut Company of Australia, http://www.pca.com.au/wp-content/uploads/2016/11/PWH-Peanut-Production-Guide-2015.pdf

8 M Bell, G Harch, J Tatnell, K Middleton (2003) The impact of crop rotation on peanut productivity in rainfed cropping systems. Australian Agronomy Conference, http://www.regional.org.au/au/asa/2003/c/5/bell.htm

Once returned to peanuts, plots were maintained in monoculture for three successive seasons to quantify residual effects of breaks. After the third peanut crop, subplots were either continued in peanut monoculture or sown to a crop rotation comprising soybeans, maize and peanuts. Opportunity sowings of winter oats (*Avena sativa*) were made after each legume crop in this rotation whenever rainfall permitted, with biomass incorporated as a green manure at the early boot stage. The peanut monoculture plots were split to treatment with and without winter oats.

Soil (0–30 cm, in 10-cm increments) was collected from subsets of plots immediately prior to planting in each season, to assess nematode numbers and soil chemical properties. Plant establishment and mortality data were recorded during most seasons, numbers of nematodes in peanut roots were determined ~6 weeks after planting, and plots were scored for the incidence and severity of symptoms caused by known soil-borne pathogens midseason and at maturity. Gross returns from peanut cropping were determined using commercial grading standards and current crop values. Crop rotations (peanuts following 1 or 2 years of grass ley or maize, or following a rotation with soybeans, oats and maize) were compared with monoculture peanuts in terms of pod yields and gross margins (derived using average costs of production from each crop and current input costs).

Peanut yields and crop value varied markedly between growing seasons (Figure 2). Yield was more responsive than crop value to breaking the monoculture. The results demonstrated that average gross returns ($/ha) were 30% higher in the break treatments than in the peanut monoculture. No aflatoxin was recorded in any year, and this was reflected in consistently high crop values.

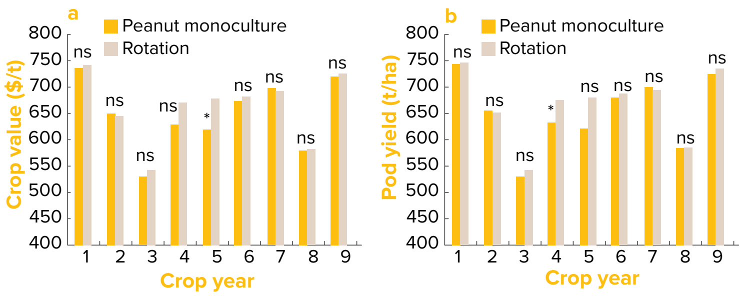

Figure 2: *(a) Crop value ($/t) and (b) pod yield (kg/ha) for peanut crops in the study at Redvale, Kingaroy. * Indicates statistical significance (P<0.05); ns, no significant differences.*

This study produced no evidence that breaks of longer than one summer season (i.e. peanuts grown every second year) were necessary to maximise crop yields and crop value (initial study phase, Table 1). Grass leys were no more effective in raising peanut productivity than rotating to maize cropping. The alternate rotation in the second phase of the study (peanuts–oats–soybeans–oats–maize–fallow–peanuts) produced significant increases in crop productivity compared with continuous peanut cropping (Table 1). Comparisons were limited by the wider range of break durations in the ley treatments than in the maize cropping (1–4 years *v.* 1–2 years). However, this limited sampling indicated that grass leys >2 years produced no additional benefits in terms of peanut yield or crop value.

Data clearly showed that introducing a winter green manure crop (oats) into a continuous summer peanut cropping pattern, as practiced in some of the newer production areas under irrigation, had no positive effect on yields or crop value. Yields were significantly lower than in the peanuts–oats–soybeans–oats–maize rotation (Table 1).

Table 1: *Effect of break duration and break type on peanut yield (t pods/ha) and crop value ($/t).*

Rotation	Years out of peanuts	Peanut yield (kg/ha)	Crop quality ($/t)
Initial phase of study			
Continuous peanut	0	1.53	$643.2
Maize	1	1.86	$630.0
Maize	2	1.98	$635.9
Grass ley	1	1.88	$648.2
Grass ley	2	1.84	$653.2
l.s.d. (*P* = 0.05)		0.21	ns
Second phase of study			
Continuous peanuts, winter fallow	0	2.28	$650.9
Continuous peanuts, winter oats	0	2.28	$659.7
Crop rotation (peanuts, oats, soybeans, oats, maize)	3	3.07	$670.4
l.s.d. (*P* = 0.05)		0.25	ns

Because there was no differentiation between break types (grass or maize) in terms of subsequent peanut productivity, data were pooled within years and an assessment was made of the residual effect of the breaks upon return to peanut monoculture. This is an important issue, because growers recognise the need to grow break crops but also want to maximise the frequency of the high-value peanut crop in the rotation. The analysis (Figure 3) clearly shows that the maximum benefit of a break was captured in the first peanut crop, with an average yield increase of 26%. Significant residual benefits persisted for only the second and third peanut crops after the break; these benefits were reduced to less than half those recorded in the initial peanut crop.

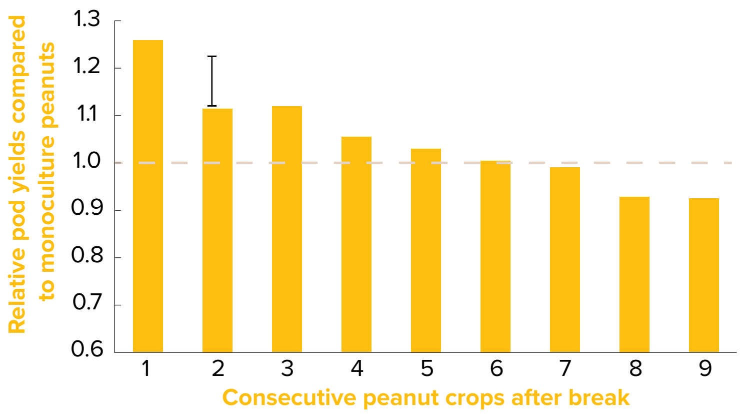

Figure 3: *Combined analysis of the residual effect of crop rotations on pod yields after a return to peanut monoculture. Length of capped line indicates significant differences (P < 0.05).*

Relationships between the potential yields in each season (yields in rotated plots) and the loss in yield or gross returns (yield × crop value) resulting from employing a monoculture were derived using regression techniques. These relationships suggested that 0.24 t pods/ha or $177 gross return/ha would be lost for each tonne of peanut yield potential in a monoculture compared with adequate rotations (R^2 = 0.81 and 0.80 for yield and gross return loss relationships, respectively). Losses in gross returns would obviously increase where crop values were greater than the average $640/t recorded during this study (e.g. under irrigation).

There was no evidence of any rotation responses resulting from changes in soil chemical fertility, as evidenced by plant nutrient status. This was not surprising considering the generous fertiliser applications used during the study. Grass leys were shown to affect soil physical fertility, in particular the ability of soils to resist crusting and allow rainfall to infiltrate. However, these changes had little impact on soil water during subsequent growing seasons and resultant yields of the peanut crops. This was due to a combination of intensive tillage after the ley minimising differences in soil structure, and the high rates of internal drainage and low plant-available water storage in these soils. Therefore, the measured peanut rotation responses were more likely due to impacts on soil health, in particular to the incidence of soil-borne peanut pathogens.

Several known soil-borne peanut pathogens were present at the experimental site during the study, including root-lesion and root-knot nematodes, crown rot (causal organism *Aspergillus niger*), Verticillium wilt (causal organism *Verticillium dahliae*), collar rot (causal organism *Lasiodiplodia theobromae*) and Sclerotinia blight (causal organism *Sclerotinia minor*). The incidence and severity of all of these organisms varied with season (e.g. Sclerotinia blight was evident only in the relatively wet 1993–94 season). The incidence of several of these organisms was affected by crop rotation (e.g. Table 2), and the combined contribution of all of the known pathogens to variation in peanut yield within any one season ranged from 5% to 50%. The smallest contribution to yield variation by these organisms occurred in the poor seasons (years 2, 5 and 8 in Figure 2b), when the predominant yield-limiting factor was water deficit.

Table 2: *Effect of crop rotation on the incidence of selected pathogens in the following peanut crop in crop years 7 and 9 (from Figure 2).*

	Continuous peanut, winter fallow		Continuous peanut, winter oats		Peanut rotated with soybean, oats, maize	
Pathogen or disease	Year 7	Year 9	Year 7	Year 9	Year 7	Year 9
Root-knot nematodes (/g DW root)	465a	1580a	690a	1775a	32b	29b
Root-lesion lesion nematode (/g DW root)	480	215	668	63	376	201
Verticillium wilt at harvest (% plants)	16.5a	47.8a	4.4b	37.8ab	3.7b	23.1b
Sclerotinia blight at harvest (% plants)	0	5.8a	0	3.6a	0	15.9b
Plant mortality due to crown rot (% plants)	23.7a	20.7a	24.6a	17.8a	1.6b	6.3b

Between rotations for the particular pathogen and growing season, means followed by the same letters are not significantly different

Seasonal rainfall conditions have the greatest impact on productivity of rainfed peanut crops in the inland Burnett. However, crop rotations involving a year without peanuts in each field will consistently result in greater peanut yields and gross returns than in peanut monocultures, with residual benefits persisting for a further two peanut crops. Rotations significantly reduced the incidence of known peanut pathogens, with the greatest benefits in terms of yield and returns occurring in high-yielding seasons.

VIDEOS

Legumes in cane

Rotations and benefits

MORE INFORMATION

Legumes make cane more able

Rotation cuts the high cost of nematodes

Peanut Company of Australia.

Australian Pesticides and Veterinary Medicines Authority.

These findings will form the basis of economic analyses to determine the optimum peanut frequency in the cropping systems of this region. [9]

1.3.2 Pesticide history

Organochloride residues in the soil and heavy metals can be a major problem for growing peanuts. The peanut fruit or pod grows directly in the soil and takes up many of its own nutrients through the pod wall. Consequently, pesticide residues and heavy metals are often taken directly into the peanut as it grows. This may then render the peanut unfit for human consumption. All new paddocks should be tested for pesticide residues prior to planting peanuts. [10] For more information, check with your processor.

1.4 Benefits of peanuts as a rotation crop

Peanuts have been shown to have beneficial effects on follow-up crops of sugarcane and cotton.

In sugarcane, peanuts can provide a break in cane monoculture, resulting in a reduction of pathogens and healthier cane stools, as well as boosting N available to the follow-up crop and improving soil structure. Peanuts also have the potential to lengthen ratoons in the follow-up cane crop. According to 2006 data from the (then) Queensland Department of Primary Industries and Fisheries, cane yields were boosted by at least 20% over the whole crop cycle. [11]

In 2005–06, peanuts were found to fix 60–90 kg N/ha in a rotation that included cotton and wheat, at Bonshaw in northern NSW. Peanuts were also thought to assist with control of nutgrass. [12]

1.5 Disadvantages of peanuts as a rotation crop

Peanuts require significant soil disturbance to reduce harvest losses (deep ripping, inter row-cultivation), making them unsuitable as a rotation crop in a full no-till situation.

Peanuts have limited herbicide options both pre- and post-emergent, so where herbicide-resistant weeds are present, peanuts may not be suitable.

As a legume, peanuts are unsuitable as a rotation with other legume crops because of the likelihood of shared pest and disease build-up.

1.6 Pre-plant weed control

Depending on the weed spectrum, weed control pre-planting can be achieved by using trifluralin or pendimethalin incorporated. [13]

1.7 Potential crop contaminants

PCA requires that all new paddocks be tested for pesticide and heavy metal residues prior to planting. These tests can be carried out at PCA's Innovation and Technical Centre. [14]

Please check the requirements of your chosen processor.

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9 M Bell, G Harch, J Tatnell, K Middleton (2003) The impact of crop rotation on peanut productivity in rainfed cropping systems. Australian Agronomy Conference, http://www.regional.org.au/au/asa/2003/c/5/bell.htm

10 G Wright, L Wieck, P Harden (2015) Peanut production guide, August 2015. Peanut Company of Australia, http://www.pca.com.au/wp-content/uploads/2016/11/PWH-Peanut-Production-Guide-2015.pdf

11 PCA. Benefits of peanuts in cane rotation. Peanut Fact Sheet. Peanut Company of Australia.

12 PCA. Cotton growers: have you considered peanuts? Peanut Fact Sheet. Peanut Company of Australia.

13 G Wright, L Wieck, P Harden (2015) Peanut production guide, August 2015. Peanut Company of Australia, http://www.pca.com.au/wp-content/uploads/2016/11/PWH-Peanut-Production-Guide-2015.pdf

14 G Wright, L Wieck, P Harden (2015) Peanut production guide, August 2015. Peanut Company of Australia, http://www.pca.com.au/wp-content/uploads/2016/11/PWH-Peanut-Production-Guide-2015.pdf

1.8 Seedbed requirements

Carefully preparing the soil is an important part of successfully growing peanuts. Peanuts prefer a weed-free, moderately fine seedbed. Because they develop an extensive root system, deep ripping to break up soil compaction may be necessary. Peanuts also require loose soil in which to peg (i.e. re-enter the soil to develop underground nuts). [15]

Peanuts produce a deep taproot capable of exploiting moisture and nutrient reserves deep in the profile. Consequently, soils prepared for peanuts should be free of any hard pans or compaction layers. Deep ripping is recommended to at least 30 cm depth in heavier soils.

Peanuts have large seed and do not require a particularly fine seedbed, but good soil–seed contact is essential to encourage rapid and even germination. Press-wheels on the planter are essential.

To encourage good crop establishment, the seedbed should be relatively even and free from weeds and excess stubble. Some growers are adopting minimum tillage practices to protect the soil surface from erosion and to improve soil structure. Discuss the implications of minimum tillage with your agronomist.

Peanuts have been traditionally planted in rows 90 cm apart, as the standard row configuration and preferred spacing to minimise losses during harvesting. Most harvesting equipment is designed to handle rows 90 cm apart; despite this, some growers have planted row spacings ranging from 65 to 100 cm. Some growers have used a twin-row planting configuration for plantings. Four rows are planted with the two outside rows 90 cm apart, and the two inside rows 70 cm apart. This configuration leads to faster canopy cover, reducing weed pressure, and generally improving yields. Twin row is particularly appropriate for ultra-early varieties.

Peanuts are normally planted on flat ground, but planting single rows on a hill or two rows on a bed can assist the digging process and improve drainage in wet areas. [16]

1.9 Soil moisture

Peanuts are considered a relatively drought-tolerant crop. They have various physiological mechanisms for avoiding the effects of drought and an extensive root system able to exploit moisture reserves at depth. Even in drought seasons, peanuts will nearly always produce some yield. However, few growers can afford mediocre yields because of the high input costs. Peanuts are best grown where the rainfall is reliable or where access to irrigation is available.

1.9.1 Dryland

Peanuts produce a yield even during dry seasons; however, in a dryland situation they need to be grown in a summer-dominant rainfall area of ~500 mm/season to reduce risk of negative gross margins.

Even during drought, peanuts will nearly always produce some yield, but few growers can afford mediocre yields because of the input costs.

To reduce risk in dryland situations, seasonal forecasts must be taken into account, and the option of supplementary irrigation is preferable as a backup. [17] Peanuts need 600–700 mm of water over the season for a high-yielding crop.

VIDEOS

Crop modelling and Aquaman

Water use and efficiency

MORE INFORMATION

SoilWaterApp – a new tool to measure and monitor soil water

Gross margin assessment for dryland peanut production in northern Queensland. Agbiz tools, Queensland Government.

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16 G Wright, L Wieck, P Harden (2015) Peanut production guide, August 2015. Peanut Company of Australia, http://www.pca.com.au/wp-content/uploads/2016/11/PWH-Peanut-Production-Guide-2015.pdf

17 PCA. Irrigation versus dryland cropping. Peanut Company of Australia.

VIDEOS

Irrigation systems and design

1.9.2 Irrigation

What will irrigation do?

Irrigation may be used to manipulate the soil conditions, especially at pegging and at harvest. The crop uses 2–6 ML/ha, depending on rainfall and soil type. Consult an agronomist to determine an appropriate irrigation schedule. If water is limited, strategic or supplementary irrigation is recommended.

Peanuts can be watered with sprinklers such as centre pivots or travelers or by flood irrigation (depending upon soil type). Trickle (tape) irrigation can be used in some circumstances. [18]

Irrigators should avoid holding off watering in favour of possible rain to minimise crop stress. Prior to planting, budget for total crop water use at 5–7 ML/ha. Peanuts are very sensitive to water stress, despite their hardiness as a crop. Minimise water stress during the critical flowering–podfill stages. Stress can increase the incidence of disease and ultimately affect kernel quality. Lack of uniformity of water application is a major issue often arising from inadequate equipment or poor system design. Soils most suited to peanuts generally have very low water-holding capacity, so water use must be carefully monitored. Know the required irrigation intervals to maintain adequate soil water. [19]

The 600–700 mm of water required over the season for a high-yielding crop can come from rain, irrigation or stored soil moisture. However, the total amount of moisture that the crop receives is not as important as the timing of rainfall or irrigation, which can have a dramatic effect on both crop yield and quality (Table 3).

Table 3: *Growth stages and irrigation needs of peanuts.*

Growth stage	Irrigation requirements
Germination and emergence	Good moisture conditions required; irrigation can ensure crop is planted on time
Vegetative	Peanuts can tolerate mild water stress at this stage; stress may be beneficial.
Peg initiation	No water stress at this stage, very sensitive; use irrigation
Pod formation and filling	No water stress; use irrigation
Maturity	Decreasing water use as the crop matures

Irrigation scheduling using a system of pan evaporation measurements and crop factors has been found very effective. Devices including tensiometers, gypsum blocks and EnviroSCAN probes, which provide indirect measurements of soil water, can also be very useful.

Irrigation systems

If water is available, it may be used to improve peanut yields and returns. The main systems used for irrigating peanuts include: furrow irrigation, or various forms of sprinkler irrigation including centre pivot, lateral moves, travelling irrigators or solid-set sprinklers. [20]

Irrigation systems include surface flow, sprinklers or various forms of micro- or drip irrigation. Each has its own uses and relative suitability.

18 G Wright, L Wieck, P Harden (2015) Peanut production guide, August 2015. Peanut Company of Australia, http://www.pca.com.au/wp-content/uploads/2016/11/PWH-Peanut-Production-Guide-2015.pdf

19 G Mills, R Rachaputi, G Wright, Y Chauhan, J Barnes (2004) Yield potential of peanuts at Mackay—What are the key barriers to obtaining it? GRDC Update Papers, February 2004, http://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2004/02/Yield-potential-of-peanuts-at-Mackay-What-are-the-key-barriers-to-obtaining-it

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Jeremy Whish CSIRO discusses target yield and stored soil moisture. GRDC Radio (Northern Update) 063: Summer cropping

Better profits from good soil water decisions (Goondiwindi)

Surface (e.g. flood or furrow) irrigation is suited to heavy soils with limited deep drainage, and to the application of large volumes of water to large areas. Energy costs are low, usually relying on gravity to move water. Surface irrigation is unsuitable for porous soils or 'fussy' crops whose water requirements are quite narrow.

Sprinkler systems range from under-tree to fixed overheads, rain guns, linear move and centre pivots. These systems can water large areas and are reasonably precise in water delivery. They require water under pressure to operate, and thus have high energy costs. They have high infrastructure costs and can be an obstacle to flexible crop husbandry. In some regions, remnant native trees may pose problems for use of centre-pivots.

Micro-irrigation systems include mini-sprinklers, drip or trickle, and subsurface irrigation. They allow precise water delivery to plants and their roots. They can be used in a variety of conditions and can maintain high-value crops in various soils. They require a pressurised water supply and can be relatively expensive to install but also provide high levels of Water Use Efficiency.

Systems with increased technology and pressurised water delivery have underpinned improvements in Water Use Efficiency in many regions. They give irrigators much more control over where water goes, how much is applied, and how much is lost to runoff, drainage or evaporation. [21]

1.10 Yield and targets

Yield expectations vary between regions (Table 4).

Table 4: *Yield expectations for Queensland crops.* [22]

Region	Expected yield
Southern Queensland dryland	1.5–4.0 t/ha (average 2.5 t/ha)
North Queensland (high rainfall) dryland	2.5 – 6.0 t/ha (average 4.0 t/ha)
Irrigated	4.0 to 8.0 t/ha (average 5.0 t/ha)

At the Douglas Daly Research Farm in the Northern Territory, results suggest that 3–4.75 t/ha of peanuts can be achieved with correct management techniques. [23]

Australian peanut producers are commonly achieving only 50–70% of the genetic yield potential of commercial peanut varieties. [24]

21 National Program for Sustainable Irrigation (2012) Irrigation essentials updated. Research and innovation for Australian irrigators 2012. National Program for Sustainable Irrigation, http://npsi.gov.au/products/npsi06121

22 G Wright, L Wieck, P Harden (2015) Peanut production guide, August 2015. Peanut Company of Australia, http://www.pca.com.au/wp-content/uploads/2016/11/PWH-Peanut-Production-Guide-2015.pdf

23 C Ham (2004) Growing peanuts in the Top End of the NT (*Arachis hypogaea* L.). NT Department of Primary Industry, Fisheries and Mines, https://dpir.nt.gov.au/__data/assets/pdf_file/0008/232928/177.pdf

24 G Mills, R Rachaputi, G Wright, Y Chauhan, J Barnes (2004) Yield potential of peanuts at Mackay—What are the key barriers to obtaining it? GRDC Update Papers, February 2004, http://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2004/02/Yield-potential-of-peanuts-at-Mackay-What-are-the-key-barriers-to-obtaining-it

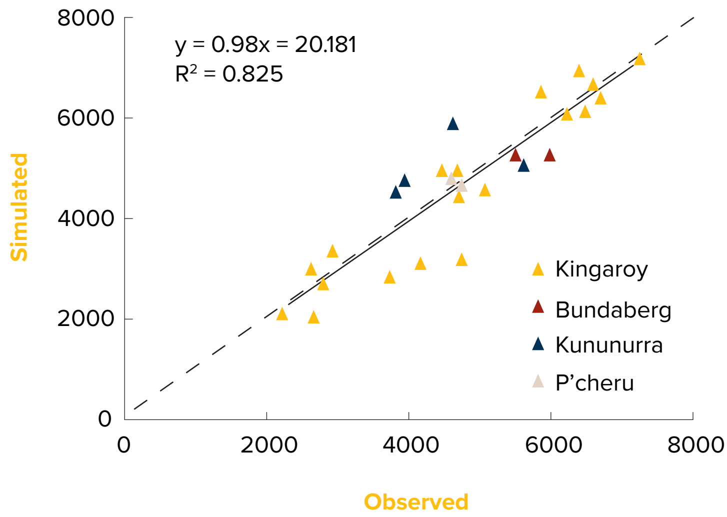

Figure 4: *Peanut pod yield (kg/ha).*

Generally growers using better practices are achieving yields in the range 4.5–7.0 t/ha, with some farmers having reported up to 8.0 t/ha (Figure 4). Frequently yields do not exceed 6.0 t/ha. Failure to align with the essential elements of best management practices (BMP) in peanut production generally results in either failure to achieve target yields or a consistent decline in yields over ensuing years (Table 5). BMP relates both to the management factors employed in the overall farming system and to the specific management techniques applied to peanut crop agronomy and management operations. New peanut growers have an excellent opportunity to implement BMP from start-up because of the collective experience of researchers and agronomists and the valuable practical knowledge of fellow peanut producers.

A GRDC-QDAF project 'Best management practices in the production of high input peanuts', Queensland Department of Agriculture and Fisheries (QDAF) has documented successful and sustainable peanut production methods.

Table 5: *Factors causing production loss in peanuts.*

Factor causing production loss	Approx. loss (%)
Inadequate/poor irrigation management	20%
Poor rotations yield decline	20%
Poor harvest management (losses wet harvests)	15%
Diseases (Cylindrocladium black rot, soil-borne and foliar diseases)	10%
Inadequate plant stands or plant populations	15%
Poor weed management	10%
Poor nutrition (micro- + macro-nutrient deficiency)	10%
Total	**100%**

Importantly, new production environments such as Mackay and the Burdekin will present new challenges for defining BMP given the specific conditions that apply in each region, particularly in relation to optimum planting and harvesting windows. However, the essential rules for successful production remain the same across regions. BMP focuses on sustainable yield in a profitable framework involving the whole farming system. [25]

1.10.1 Seasonal outlook

For more information, visit the Bureau of Meteorology, Climate outlooks.

1.10.2 Fallow moisture and double-cropping

The Agricultural Production Systems Simulator model (APSIM) was used to simulate the relative benefits of double-cropping (wheat and peanuts) over peanuts with a winter fallow in the Burnett district of Queensland. Simulation results demonstrated that, in general, double-cropping could be practiced successfully in the South Burnett. [26]

Background

Double-cropping is frequently practiced on Red Ferrosols in the Burnett district. Wheat is commonly planted after peanuts with very little stored water at planting. In some instances, wheat is planted almost immediately after a peanut crop if planting rainfall (25 mm) has occurred. In many cases, the resulting wheat crop is not viable. Questions have been raised about the validity of this double-cropping practice: how often does the wheat crop jeopardise the following peanut crop, and what are the long-term yields for wheat and peanuts planted in this way?

One way to address this issue is with simulation models. APSIM is a cropping system model capable of integrating the effects of weather, soil and cropping management. We used APSIM to investigate the viability of double-cropping in the Burnett.

APSIM was parameterised for a typical Red Ferrosol soil near Kingaroy. Two cropping systems were simulated: peanut following wheat, and peanut with a winter fallow. Plant-available water (PAW) capacity for the soil simulated was 110 mm to a depth of 1.8 m. The lower limit of water extraction for the two crops was derived from experimental data. In the model, wheat was planted between 1 May and 31 July when available water in the top 0.50 m was >25 mm. Peanuts were planted between 15 October and 31 December on ≥55 mm or more PAW in the top 0.50 m. A 90-year weather record for Kingaroy was used.

Outcomes

Simulated median peanut yields were 2.8 t/ha in the peanut–wheat rotation and 2.9 t/ha in the peanut-only system. The distributions of peanut yields from the peanut–wheat and peanut-only systems were similar. This indicated that, on average, wheat did not reduce planting soil moisture or yield of the following peanut crop. This was because the peanut crop commonly received adequate soil water after planting to maintain yields. Even if soil water at planting was high, low in-crop rain could result in low peanut yields. In general, a winter fallow did not result in improved utilisation of rainfall for peanut growth, or increased yields. [27]

1.10.3 Water Use Efficiency

Peanuts and other tropical legumes often face water stress, but planting cultivars with high Water Use Efficiency can minimise the yield losses in times of stress.

Go 'on-farm' to hear Queensland peanut growers discuss Water Use Efficiency.

MORE INFORMATION

RD Connolly *et al.* (1998) Simulating peanut/wheat cropping in the Burnett with APSIM. Australian Agronomy Conference.

PCA/DPIF. Managing weeds.

VIDEOS

Water use and efficiency

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KT Hubick *et al.* (1986) Correlation between Water Use Efficiency and carbon isotope discrimination in diverse peanut (*Arachis*) germplasm. *Australian Journal of Plant Physiology* 13.

P Songsri *et al.* (2013) Association of stomatal conductance and root distribution with Water Use Efficiency of peanut under different soil water regimes. *Australian Journal of Crop Science* 7.

Research shows that remote-sensing imagery of irrigated peanut crops with simple airborne digital video camera systems offers growers and consultants a cost-effective technique for the assessment of spatial variability in crop performance. Images of near-infrared reflectance (NIR) taken from irrigated peanut crops (pivots) in southern Queensland showed major variability arising from crop stress, most likely a result of poor irrigation distribution and/or poor water infiltration (Figure 5).

The NIR from peanut crops taken ~4–6 weeks before harvest was highly correlated with final pod yield, and this offers a potential yield-forecasting technique for growers and industry. The close association also allows an assessment of the magnitude of the yield deficit resulting from spatial variability (or 'yield gap'). This provides growers and consultants with a useful method to calculate the economic impact of reducing the yield gap in their own fields and has potential for use as a strategic tool to identify problems and improve various aspects of crop management.

The research has shown that NIR images can provide growers with indicative yield maps and the likely yield gap and resulting reduction in gross income prior to harvest. The imagery can direct crop inspection and hence the detection and early warning of water, disease, nutrient and other stresses for potential in-season management. The strong relationship between NIR and pod yield in peanut crops also suggests potential for using the technology as a yield-forecasting tool for regional irrigated and rainfed production, with a significant potential role in other field crops. [28]

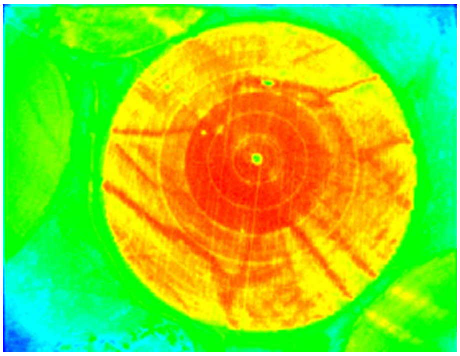

Figure 5: *Peanut pivot in the Texas region, Queensland, showing extreme crop variability associated with poor soil infiltration and distribution in the outer pivot.*

1.10.4 Nitrogen-use efficiency

Like other legumes, peanuts are able to produce their own N via a symbiotic relationship with a strain of the soil bacteria rhizobia. These beneficial bacteria infect the peanut root system and forms characteristic nodules, from which N_2 gas is 'fixed' from the atmosphere. The N is then available to the plant for growth and development. For peanuts, use Group P rhizobial inoculum.

Not all legumes grown by Australian farmers have the same capacity for N_2 fixation (Table 6). Of the crop legumes, navy beans are weak, fixing only ~20% of their needs with the remainder supplied from soil and fertiliser sources. On the other hand, faba beans, lupins and soybeans that have good capacity for N_2 fixation. Peanuts, field peas, lentils, mungbeans and chickpeas are in between. [29]

28 G Wright, A Robson, G Mills (2004) Application of remote sensing technologies to improve yield and Water Use Efficiency in irrigated peanuts. 12th Australian Agronomy Conference, Australian Society of Agronomy, http://www.regional.org.au/au/asa/2004/poster/1/5/698_wrightg.htm

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Table 6: *Estimates of the amounts of N_2 fixed annually by crop legumes in Australia.*

Legume	%Ndfa	Shoot DM (t/ha)	Shoot N	Root N	Total crop N	Total N
			(kg/ha)			
Soybeans	48	10.8	250	123	373	180
Lupins	75	5.0	125	51	176	130
Faba beans	65	4.3	122	50	172	110
Field peas	66	4.8	115	47	162	105
Peanuts	36	6.8	190	78	268	95
Chickpeas	41	5.0	85	85	170	70
Lentils	60	2.6	68	28	96	58
Mungbeans	31	3.5	77	32	109	34
Navy beans	20	4.2	105	43	148	30

Source: primarily Unkovich et al. 2010

%Ndfa, Percentage of legume N derived from N_2 fixation; DM, dry matter; root N = shoot N × 0.5 (soybeans), 1.0 (chickpeas) or 0.4 (remainder); total N fixed = %Ndfa × total crop N

1.11 Disease status of paddock

Peanuts are susceptible to several soil-borne diseases, especially Sclerotinia blight, white mould and Cylindrocladium black rot. Good rotational practices, crop management and hygiene are the best defences against these diseases. Limited fungicide options are available to combat peanut soil diseases.

Soil-borne diseases can lead to substantial yield and quality loss. Although some products are available to lessen the effects of these diseases, the best policy is to follow a recommended rotational program (involving grass or cereal crops) and practice good cultural management. In particular, excessively aggressive cultivation should be avoided, especially where soil is pushed against the plant.

Sclerotinia blight can be particularly devastating in some areas. It is recommended that a registered fungicide spray be used and applied as a protectant before symptoms appear. This may be as early as when the crop is 6–8 weeks old, or when the first flower petals drop. One or two follow-up fungicide applications may be required if symptoms develop. [30]

1.12 Insect status of paddock

Peanuts can tolerate higher insect thresholds than other, more determinate crops, because they compensate growth following damage.

Peanuts are indeterminate in vegetative and reproductive development. This means the plants do not stop growing in order to flower and produce a crop. They continue to grow leaves and stems while also flowering and setting pods. The pods must therefore compete with the shoots for carbohydrate and nutrients.

In traditional peanut-growing areas (e.g. the South Burnett), soil pests can cause major economic damage. Foliar pests rarely cause economic damage. The worst soil-insect damage usually occurs where there is a long history of peanut growing with few non-legume crops in the rotation.

In drought years, *Etiella* is a major problem in dryland crops. *Etiella* larvae are able to reach the pods in dry soil, and damaged pods are at greatly increased risk of aflatoxin contamination. Most other pest problems occur only occasionally.

As peanuts expand into newer areas, some pests, such as *Helicoverpa*, mites and mirids, will be a more constant problem. Soil pests are likely to become important in

30 G Wright, L Wieck, P Harden (2015) Peanut production guide, August 2015. Peanut Company of Australia, http://www.pca.com.au/wp-content/uploads/2016/11/PWH-Peanut-Production-Guide-2015.pdf

MORE INFORMATION

QDAF (2010) Soil insects in Queensland.

H Brier *et al.* (2012) Good bug? Bad bug? An identification guide for pests and beneficial insects in summer pulses, soybeans, peanuts and chickpeas.

newer areas as more peanuts are grown, and new species may be encountered that are specific to the soil type in question. Pest damage to peanuts can start as soon as the crop is planted and it continues until maturity. Under intensive production, a number of pests will warrant control. [31]

31 QDAF (2010) Insect pest management in peanuts. Department of Agriculture, Fisheries and Forestry Queensland, https://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/ipm-information-by-crop/peanuts