13. AGRONOMIC DATA

Enumerators were asked to mark out five small sample plots in each sample field in order to measure plant characteristics, pest attack and damage, take soil and groundwater samples, and harvest by hand. The agronomic measurements generated considerable data that are impossible to comprehensively summarise in this report. This section provides only an indication of the material available.

To summarise the data on cotton, farms were allocated to one of five zones as follows:

Table 13.1 Zoning of Farms for Summary of Cotton Data

Zone	Farm Nos.	Location (1)	Altitude (1)	Other details	Av. Yield (t/ha) (2)
1	17, 18, 21, 22	South (37.4N:64.6E)	Middle (315m)		3.0
2	25, 26, 27	North West (41.8N:60.1E)	Low (87m)		2.6
3	3, 4, 23, 24, 35, 36	Central (40.1N:67.1E)	Middle (256m)		2.5
4	14, 37	South East (40.2N:70.3E)	Middle (363m)	Poor soil	1.6
5	9, 10	East(40.4N:72.9E)	High (914m)		2.6

Notes: (1) Coordinates and altitude are means for farms in zone.
(2) Yield based on hand harvesting of sample plots.

This simple zoning takes account of major climatic variations in that the summer is shortest in zones 2 and 5 and longest in zone 1. To a small degree it corresponds with some of the main soil variations in that saline soils are most common in zones 1, 2 and 3 and absent in zone 5, and soils in zone 4 are coarse-textured colluvium compared with the alluvium/aolian deposits of the other zones. However, there is considerable variation in soil characteristics within these zones, variation in groundwater depth, and variation in the agronomic practices applied to the crops.

13.1 Plant Population in Cotton

Plants were counted in sample plots in March, June and October and values recorded as plants per metre for row crops, or per square metre for broadcast or narrow-drilled crops. March was the main count for winter wheat, and June and October the main counts for summer crops. The averages by zone for cotton are given in Table 13.2.

Table 13.2 Average Plant Population in Cotton (‘000/ha)

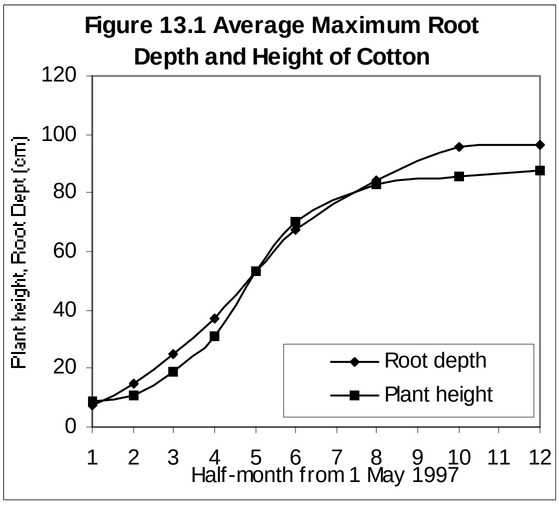
Zone	March	June	October
1	-	114	106
2	-	91	80
3	231	122	127
4	-	120	103
5	-	111	108

Little cotton had been planted in March but counts of germinated seedlings on two farms revealed very high plant populations. By June, initial thinning had been completed in most but not all fields, and plant populations averaged around the expected value of 120,000 plants per ha. Much lower populations were recorded on farms in the Aral Sea delta zone. By October, populations mostly had decreased a little compared with the earlier count.

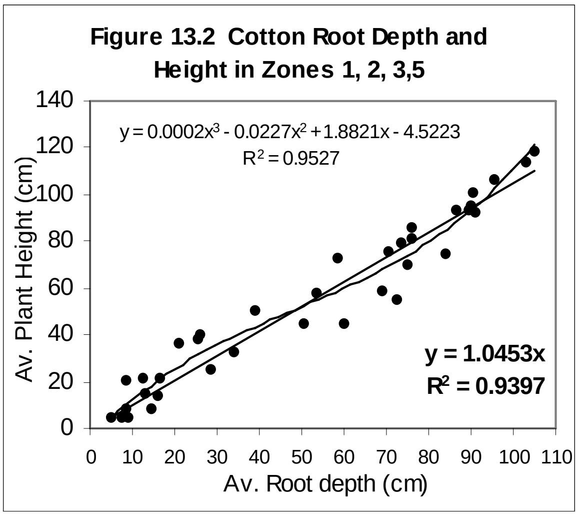
These plant populations for cotton, grown mostly in 90cm spaced rows, are extremely high by international standards (30-50,000 plants/ha). This is a deliberate agronomic practice to maximise yield where the period of ideal climatic conditions for cotton is extremely short. The strategy has been to breed varieties that flower early when plants are small and harvest fewer bolls per plant from more plants per ha.

13.2 Plant Height and Rooting Depth in Cotton

Cotton is mostly sown in April but where conditions are suitable in late March. Late plantings, and replanting after germination failure, extend into June. The climate during this period is very unfavourable to growth of cotton, with a high frequency of cold and wet days and low night temperatures. Seeds germinate with the warm daytime temperature but vegetate until the night temperatures remain above the critical 15°C limit, normally in the second week of June in most areas. This point in time marks the start of rapid vegetative growth, but as the chronological age of cotton plants exceeds their physiological age, it is unusually short and flowering begins mostly in late June and peaks in late July. Growth is illustrated in Figure 13.1, based on the averages of plant height by half-month of all records for cotton in 1997.



The rate of vegetative growth is most rapid and linear between the first half of June until the second half of July (half-months 3 to 6). The onset of flowering re-allocates assimilates from growth extension to boll formation and the rate of increase in height slows to a peak in mid-September. Topping of the plants in some fields accentuates the slowing of growth, but with an average final height of less than 0.9m, Central Asian cotton plants are short.



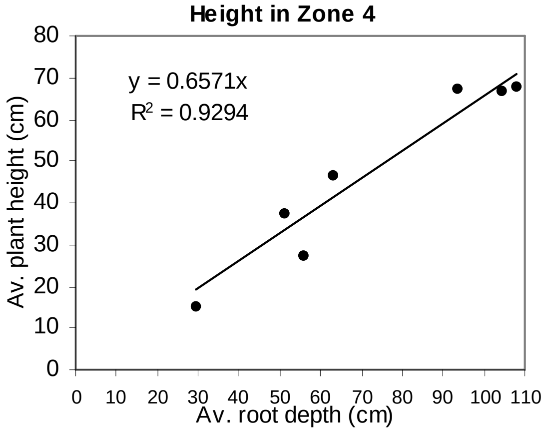
The extension of roots mirrors the above-ground growth as shown in Figure 13.1. In early season, there is a lag in root extension, by early July roots are as deep as the plant is tall and by September, roots are still extending as stem growth has stopped. This reflects in a slight polynomial relationship between plant height and root depth, illustrated in Figure 13.2. However, the cubic polynomial r^2 value of 0.95 is only marginally better than the r^2 of the linear fit (in bold), so that the simple linear relationship appears to be adequate. Furthermore, for the farms in all zones except zone 4, the linear coefficient is effectively 1.0 so that plant height provides a reasonable measure of root depth. This is practically important for two reasons. Firstly, ideal irrigation schedules are more sensitive to the assumption of root depth than other factors, such as daily variation in rate of evapotranspiration, and the AWC of the soil. Secondly, regular monitoring of root depth in the field is difficult and time consuming compared with measuring crop height.

There are some important qualifications to this generalisation for the 1997 data:

- it may possibly be affected by the climatic peculiarities of any particular season
- root extension is markedly affected by an indurated horizon in the soil such as a ploughpan or a gypsic horizon (see Section 14)
- the irrigation system affects root depth, well-managed drip irrigation for example, limiting root extension to the percolation depth of water, which may be only 30cm
- roots in coarse textured soil with low AWC will range deeply for water.

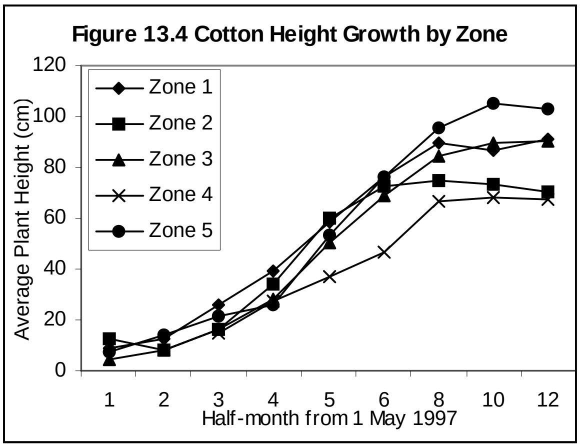
This last point is illustrated in Figure 13.3 based on data from the farms in Tadjikistan, located on the colluvial slopes of the mountains flanking the Ferghana Valley.

Figure 13.3 Root Depth and Cotton Height in Zone 4

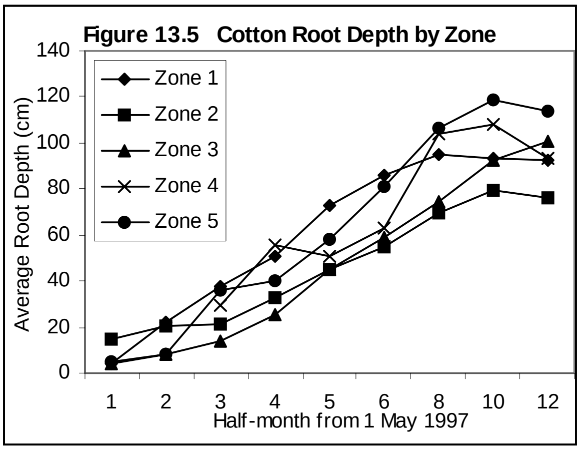


In these sample fields of zone 4, on average roots are 50 percent deeper than the plants are tall.

The extent of zonal variation in growth characteristics of cotton plants is illustrated by their averages, shown in Figures 13.4 and 5. The handicap of the infertile soil and inadequate irrigation regime is shown by the development curve for plant height for zone 4. The benefit of warmer temperatures in zone 1 is seen in the more rapid growth in June and July, and conversely the slower development in zone 5 is the consequence of cooler temperatures. The effect of the short season in the most northerly areas is seen in the end to growth extension in July, but it is not clear if this is due to cooling temperatures or problems with the irrigation system in the lower reaches of the river systems. Particularly interesting, is the continued growth well into September of the high altitude cotton in zone 5, that suggests the problem in zone 2 may not be the consequence of falling temperature.



On account of the close relationship between crop height and root depth, the zonal variation in rooting follows a similar pattern to above-ground extension as shown in Figure 13.5.



The main difference is the rapid growth of roots in the coarse-textured soils of zone 4 during June and August because of irrigation deficit.

13.3 Flowering and Boll Development in Cotton

Using data from all sample farms, the average data on flowering and boll formation are shown in Figure 13.6.

In the warmer and early-planted areas, cotton flowering begins in early June, but most generally in late June. By early July, there was an average of one flower per plant per day and this rose to nearly three by the end of July. From August onwards there is a steady decline in flower production as bolls are set, but even in September there was about one flower per plant daily.

Setting of the first flowers and development of these first bolls is vital to heavy yield of good quality cotton, in this region of exceptionally short season for cotton. Later bolls are smaller, their fibre is immature and the quality is adversely affected by dews and early rains as they split during autumn. Furthermore, due to shortage of labour for harvesting and the reluctance of pickers to harvest sparse bolls in inclement weather, the late bolls often remain unharvested.

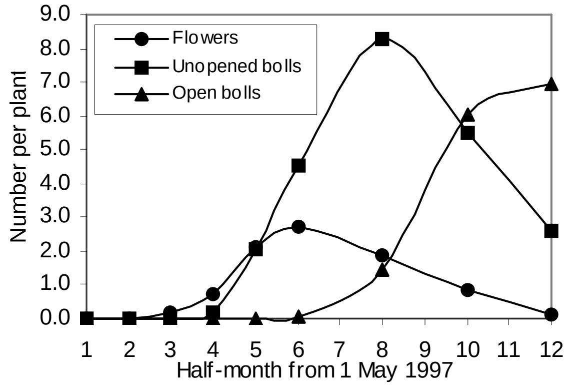


Figure 13.6 Average Flowering, Boll Set and Boll Split in Cotton

Figure 13.6 shows that the number of unopened bolls peaks during August with an average of more than eight bolls per plant. As bolls split, the number declines thereafter and the number of open bolls increased accordingly. Boll split begins in late July and increases rapidly during August and September, sharply declining in October. During October, there were approximately seven open capsules per plant, representing those that were harvested or could be harvested.

The integrals of the flowering and boll formation curves in Figure 13.6 shows that many more flowers and bolls are produced than reach maturity. The dehiscence of flowers and bolls is a normal feature and the result of physiological imbalance between the net assimilation rate of the canopy and the conflicting demands of respiration, vegetative growth and boll development. Net assimilation rate is a function of the leaf area index, stress caused by weed competition, pest attack, salinity and water logging, atmospheric conditions, and the supply of nutrients and water from the soil. Unfavourable levels of any of these factors will cause shedding of flowers and immature bolls. In the special case of cotton, attack on developing bolls by pests such as American bollworm and biting and sucking insects causes dehiscence.

From average data, 110,000 plants per ha and seven bolls per plant each of 3.5g, the yield of raw cotton is 2.7t/ha. This contrasts with the actual yield assessment of cotton, overall weighted averages of 2.5t/ha in sample plots and 2.3t/ha based on field records. The reason, discussed below, is most likely due to misunderstanding by some of the enumerators in counting open capsules, and that the average number per plant is more likely to be eight but that average boll weight is less. An average boll weight of 3.3g is very light and the consequence of the cotton breeding strategy of the region. Future breeding strategy might aim to raise this value and the ginning outturn at the same time. Improvements in agronomic management should aim to increase the number of early-formed bolls retained by the crop by reducing the stresses on the crop by the factors mentioned above.

Patterns of flower production are quite similar in zones 1, 2 and 3 as shown in Figure 13.7 except that flowering in the southern zone is earlier and more prolific, and later and less prolific in the northern zone. Interesting observations are the very early and prolific flowering in the crops on the poor soils of zone 4, and the mid-season spurt in flowering in the cotton at high altitude.

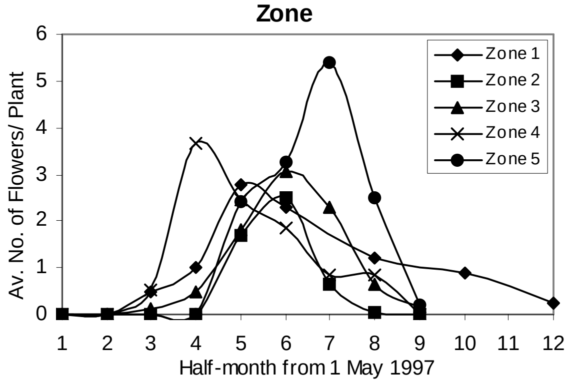


Figure 13.7 Flowering in Cotton by Zone

Zonal variation in boll splitting is illustrated in Figure 13.8. Open capsules are not shed by the plant so that it is technically impossible for the counts to decrease between September and October as shown for zones 2 and 5. This reflects perhaps an element of random error in counting and processing data, or more likely misunderstanding by the enumerators that they should count all the capsules whether or not they still contained fibre. It is likely therefore that the overall average number of split bolls should be greater than seven per plant, as discussed above.

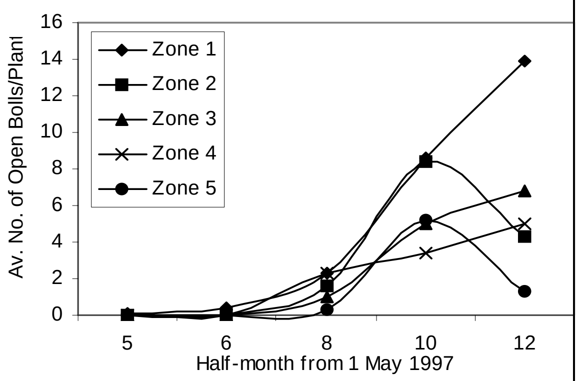


Figure 13.8 Cotton Boll Splitting by Zone

Boll splitting in crops in the southern zone was marginally ahead of other areas with the exception of zone 4 where it seems that water stress may have hastened the process. Boll counts in September ranked the zones in the same order as the recorded final yields.

13.4 Weed Competition

Enumerators were requested to count weeds in the sample plots in March, June and October and assess weed competition on a subjective score of 0 (nil) to 4 (severe). Data from farm 27 have been ignored as much greater than other farms, and the competition scores are too variable, with too many blanks, to be reliable. Weeds populations in cotton are summarised by the zones described above, as shown in Table 13.3.

Weed populations were mostly less than one percent of cotton seedling counts in both June and October. Between these two dates there was an increase in weed numbers in zones 1 and 2 but a decrease in zones 3 and 4.

A few counts were made in March and fields that had not been interrow cultivated had weed populations of 100-250,000 per ha. These were the weed populations in June and October in the fields of Farm 27, where the records reveal that no labour was used for weeding the cotton fields and only a single interrow cultivation was made. The very poor yield of cotton, average 1.6 t/ha, is almost certainly attributable in part to weed competition.

Table 13.3 Weed Populations in Cotton Crops ('000/ha)

Zone	June 1997	October 1997
1	0.33	0.86
2	0.17	0.45
3	1.42	0.39
4	1.44	0.91
5	0.18	-

13.5 Pests and Diseases

Enumerators were asked to record the date of the first siting of pests and diseases in the sample fields, to record the name of the organism, and to assess the damage to the crop on a score from 0 (nil) to 4 (severe). Enumerators were mostly trained as engineers and none were entomologists or pathologists, but they were asked to seek the help of the farm specialists. Most failed to do so and records are very far from complete. The enumerators of farms 21 to 24 (Surkhandariya and Syrdariya) in Uzbekistan did a particularly good job of recording pests as requested but it should be noted that this creates a possible bias in the data.

13.6 Cotton Pests and Diseases

Records are summarised for cotton in Table 13.4.

Table 13.4 Pests and Diseases of Cotton

Latin name	Common name	Date of first report of			Damage score (0=nil, 4-severe)					No. of reports in 1997
		eggs	larvae/ nymphs	adults/ fungus	May	Jun	Jul	Aug	Sep	
Heliothis armigera	American bollworm	18-Jul	23-May	23-May	0	1.1	1.5	1.4	1.0	62
Tetranychus telarius	Spider mite	21-Jun	25-May	25-May	0	1.6	1.8	0.9	0	51
Aphis (laburni)	Aphid	-	20-May	20-May	0.5	1.8	1.0	1.0	1.0	37
Spodoptera (Laphygma) exigua	Cotton leafworm	-	05-May	20-May	0.8	2.0	1.0	1.0	1.0	29
Fusarium/Rhizoctonia	Root rot	-	-	11-May	1.8	0	0	0	0	16
Chloridea dipsacea	Cutworm	-	20-May	20-May	0	1.0	1.0	0	0	15
Agrotis segetum	Cutworm	21-Jun	20-May	20-May	0	1.1	1.0	0	0	12
Acyrtosiphon lineolatus	Big cotton aphid	-	16-May	16-May	1.0	1.0	1.0	1.0	1.0	11
Euxoa segetum Schiff.	Cutworm	-	20-May	20-May	0.3	1.0	1.0	0	0	9
Lema melanopus L.	Beetle	-	20-May	20-May	0	0	0	0	0	4
Verticillium dahliae	Verticillium wilt	-	-	01-Jul	0	1.0	1.0	0	0	4
Adelphocoris lineolatus	Sucking bug	-	01-Jul	01-Jul	0	0	1.0	0	0	2
Thielaviopsis basicola Ferr.	Pima root rot	-	-	01-Jul	0	0	2.0	0	0	2
Bemesia tabaci	White fly	-	-	25-May	0	0	0	0	0	1

In all, some 11 pests and three diseases were noted. Of these, American bollworms, spider mites, aphids, leaf-eating caterpillars and cutworms were the most common. Root rot caused (most likely) by *Fusarium and Rhizoctonia spp* was also common but verticillium wilt was not.

The first recorded pests were cotton leafworms in early May, followed shortly by cutworms and aphids. The damage caused by aphids and leafworms was quite serious in some fields but crops quickly recovered. Larvae and adults of American bollworm were first noted in late May and their eggs rather later. The adults most likely would have over-wintered, but the record of larvae so early in the season is more difficult to explain. No damage was reported in May but by June, some damage was being reported, rising to a low-moderate level in June to August. In only three out of 40 fields where this pest was reported, did damage reach a serious level. Mostly the damage scores were very modest. Spider mites were reported in 31 fields and in some quite early. However, damage peaked in June and July to generally low-moderate levels and became serious in only three fields. Aphids were recorded in 19 fields from mid-May and although the damage caused never became serious, there was a visible level present throughout the season with a peak in June. Cutworm damage was widespread but damage was only more serious than score 1 in a single field, where the problem was serious.

Non-specific root rot was also noted in mid-May but the rare root rot of pima cotton was much later. Every one of the 18 records of root rot was in a different field and most commonly; the damage was scored at level 2. This relatively serious level of loss of seedlings may not be typical for the region but may have been caused by the exceptionally wet and sometimes cold spring during germination and the lack of seed treatment.

13.7 Wheat Pests and Diseases

In the sample fields of wheat, 13 pests, four fungal diseases and one viral disease were noted as shown in Table 13.5. The two most common diseases were mildew and stem rust, and haplothrips, aphids and leaf beetles were the most common insects.

Table 13.5 Pests and Diseases of Winter Wheat

Latin name	Common name	Date of first report of			Damage score (0=nil, 4-severe)					No. of reports in 1997
		eggs	larvae/ nymphs	adults/ fungus	Feb	Mar	Apr	May	Jun	
Erysiphe graminis	Mildew	-	-	05-Mar	0	0	0.8	1.3	0	12
Haplothrips tritici Kurdj.	Semi-thrips	-	05-Mar	05-Mar	0	0	1.5	3.1	0	9
Aphis	Aphids	-	20-Mar	20-Mar	0	1.0	1.0	1.0	1.0	9
Puccinia triticina	Stem rust	-	-	10-Mar	0	1.0	1.0	1.0	0	8
Lema melanopus L.	Leaf beetle	-	05-Mar	05-Mar	0	0	1.8	2.0	0	8
Ustilago tritici	Smut	-	-	03-May	0	0	0	0.8	0	5
Eurygaster intergriceps	Bug	11-Mar	-	05-Mar	0	1.0	1.5	0	0	5
Oscinella pusilla	Swedish wheat fly	-	01-Apr	01-Apr	0	0	0.3	1.0	0	5
Dociostaurus maroccanus Thnb.	Locust	-	01-Apr	01-Apr	0	0	1.0	0	0	5
Myridae	Capsid bugs	-	-	10-Mar	0	0	0.5	1.0	0	4
Mayetiola destructor Sac.	Hessian fly	-	01-Apr	01-Apr	0	0	1.0	2.0	0	4
Puccinia glumarum	Glume rust	-	-	20-Mar	0	0	0	2.0	0	3
Formica	Ant	03-May	-	03-May	0	0	0	1.3	0	3
Sinops Gyll.	Weevil	-	-	01-Apr	0	0	1.0	0	0	2
Acricloiclea	Locust	-	-	05-Apr	0	0	1.0	0	0	2
	Striped mosaic virus	-	-	25-Mar	0	1.0	1.0	0	0	2
Cephus pygmalus	Grain beetle	-	04-Apr	05-Apr	0	0	1.0	1.0	0	2
Bemesia tabaci Genn.	White fly	-	-	25-Mar	0	0	1.0	0	0	1

No pests or diseases were recorded in the months after planting until March 1997. The first to appear were aphids, stem rust, some sucking bugs and a single case of leaf virus, all causing some slight damage. As crops booted with the warmth of April, several other pests appeared together with the mildew. By May, several insects were causing moderate damage, mildew intensified somewhat and glume rust appeared on the inflorescences causing moderate damage. As the crops matured in June, aphids maintained their presence as they had done all spring.

13.8 Pests and Diseases of Lucerne

No disease but 17 insect species were recorded during the year in the lucerne sample fields, as shown in Table 13.

Table 13.6 Pests and Diseases of Lucerne

Latin name	Common name	Date of first report of			Damage score (0=nil, 4-severe)									No. of reports
		eggs	larvae/ nymphs	adults/ fungus	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	
Phytonomus variabilus	Lucerne beetle	10-Feb	10-Feb	10-Feb	3.0	3.0	1.8	2.3	1.0	1.0	1.0	1.0	0	21
Aphis	Aphid	-	10-Mar	01-Apr	0	2.0	2.0	1.5	1.3	1.0	1.0	1.0	1.0	15
Adelphicoris lineolatus	Sucking bug	-	10-Mar	10-Mar	0	1.0	0	1.5	1.0	1.0	1.0	1.0	1.0	13
Spodoptera (Laphygma) exigua	Lesser armyworm	21-Jun	20-Feb	01-Apr	2.0	3.0	1.0	0	1.0	2.0	1.0	1.0	0	9
Thrips tabaci	Thrips	-	-	10-Mar	0	0	0	1.0	0	1.0	1.0	1.0	0	5
Chloridea dipsacea	Cutworm	-	01-Jul	01-Jul	0	0	0	0	0	1.0	1.0	1.0	1.0	4
Agrotis segetum	Cutworm	-	03-May	03-May	0	0	0	0	0	1.0	0	0	0	2
Heliothis armigera	Amercian bollworm	-	01-Aug	-	0	0	0	0	0	0	2.0	0	0	2
Euxoa segetum	Cutworm	-	03-May	03-May	0	0	0	1.0	1.0	0	0	0	0	2
Loxostege sticticalis	Meadow moth	-	01-Sep	-	0	0	0	0	0	0	0	1.0	1.0	2
Phytomera gamma	Cutworm	-	02-Sep	-	0	0	0	0	0	0	0	1.0	1.0	2
Bruchphagus roddi	Weevil	-	01-Aug	01-Aug	0	0	0	0	0	0	0	1.0	1.0	2
Contarina medicounis	Lucerne midge	-	-	01-Aug	0	0	0	0	0	0	0	1.0	1.0	2
Acyrtosiphon gossipi	Big cotton aphid	-	01-Apr	-	0	0	1.0	0	0	0	0	0	0	1
Miridae	Capsid bug	-	-	10-Mar	0	0	0	0	0	0	0	0	0	1
Acricloiclea	Locust	-	-	05-Apr	0	0	0	0	0	0	0	0	0	1
Dociostaurus maroccanus	Locust	-	01-Jul	01-Jul	0	0	0	0	0	1.0	0	0	0	1

The most important pests were lucerne beetles, aphids, sucking bugs and the lesser armyworm, in how common they were and the level of damage they caused. Lucerne beetles and armyworms appeared in February, causing moderately serious damage throughout the spring months. Aphids and sucking bugs appeared a month later, quickly causing moderate damage during spring. All these pests were present throughout the summer until September. Most of the other recorded pests appeared during the summer or autumn and caused only slight damage.

There was a sudden appearance of the American bollworm in August causing moderate damage, demonstrating the wide host spectrum of this pest and that control measures for cotton would need to take account of larvae feeding on lucerne.