

# Alternative to plastic mulches

## Summary

The benefits of mulches are numerous. They reduce temperature fluctuations in the soil, reduce water loss through evaporation and protect the soil surface.

In organic systems they also play a key role in weed control, where hand-weeding would otherwise add substantially to the cost of growing a crop. Managing larger areas of plants that are not competitive, especially onions, can take a lot of time hand weeding. The main drawback is that many mulches are made of plastic. Although some of the tougher woven plastics have a longer life of at least a few years, when these start to break down, they often deposit small fibres into the soil.

Therefore we wanted to test some alternatives. Garden Organic tested a standard woven plastic 'weed fabric', a biodegradable starch based plastic mulch and a paper mulch at 72 of its members' sites. A crop of onions was grown with the sets planted through the mulch, and the growth of the crop, weeds, yields and pests and diseases were monitored.

They were assessed for weed growth once a month, and were weeded just after assessment and then weeds were allowed to grow back again before the next assessment.

Generally, all the mulches reduced the weed ground cover from 20% to just 5%. The main weeds were annual meadow grass, chickweed and fat hen in the unmulched control plots. Bindweed was the most common weed in the mulched plots, as it was able to grow through the holes for the onions and start to cover the mulch.

Mulching increased yields by around 10%, partly through decreasing weed competition and also through retaining moisture. It also reduced the amount of time weeding from 45 minutes to 10 minutes throughout the season. It was a very dry summer, and in a wetter year, we may have expected to need to weed the unmulched control plots for longer.

The mulches resulted in a slight increase in numbers of slugs, but this increase was only small. Again, as a result of the dry weather, slug numbers were low generally, so it would be interesting to observe this effect under wetter conditions.

The paper mulch was starting to break down into large pieces by the time it came to harvest, whereas the biodegradable plastic was just starting to break down at the edges. Some people were concerned over the long time that this material takes to break down, which is stated as 36 months by the manufacturer. There is also the worry over the lack of knowledge of the impact that these bioplastics have when they break down in the soil.

Overall, the paper mulch was the most popular to use, as it was easy to lay, and could be seen to be breaking down by the end of the season. It is also one of the most expensive to use, having an annual cost of £1.60 – £2.40 per square metre. Weed fabric has a similar cost, but this is spread over a number of years of the lifetime of the product.

## Background



The benefits of mulches are numerous. In cooler weather they tend to warm up the soil, whereas in warmer weather they tend to cool it down (Arora *et al.*, 2011, Pramanik *et al.*, 2015). They reduce water loss through evaporation (Agassi *et al.*, 2004, Ji and Unger, 2001) and will also protect the soil surface, reducing loss of topsoil (Lal, 1974).

In organic systems they play a key role in weed control, where hand-weeding would otherwise

add substantially to the cost of growing a crop. Managing larger areas of plants that are not competitive, especially onions, can take a lot of time hand weeding. If the weeds are not controlled adequately, then the yields can be severely compromised. Also harvesting amongst a tangled mess of weeds suddenly becomes a very long winded and daunting task.

The main drawback is that many mulches are made of plastic. Although some of the tougher woven plastics have a longer life of at least a few years, when these start to break down, they often deposit small fibres into the soil. Some people may question the environmental credentials of avoiding herbicides but replacing them with large areas of plastic. Although the environmental impact of using a herbicide is considerable, these impacts are not nearly as visible as the sight of a large area of plastic.

This problem has been recognised by the horticultural industry, and there are now a choice of biodegradable mulches available. Some are made of starch based plastics that can degrade in the soil or compost when they are finished. Others have been around for a while, such as paper mulches, but are now being promoted more widely. We should also be aware that gardeners have been using their own biodegradable mulches such as grass, bark chippings and cardboard for years.

This trial was carried out in conjunction with the Organic Plus project at Coventry University's Centre for Agroecology, Water and Resilience, which aims to find alternatives to contentious inputs, such as plastics, within organic horticulture.

### **Aims of this experiment**

We wanted to examine the effects of various mulches on yields, plant development and weed development. We wanted to test some biodegradable alternatives - examining their effectiveness as a mulch and how well they degrade.

## **Mulches used**

We tested the following:

1. Standard plastic woven mulch, often referred to as 'weed fabric'. These mulches are not biodegradable, but can be reused for a number of years. However, they do have a tendency to deposit shreds of plastic fibres from the edges where they are cut, contributing to microplastic pollution in the soil.
2. Biodegradable plastic mulch. This was a starch based plastic film that will biodegrade when incorporated into the soil. These films are now becoming more commonly used by organic growers for weed control.
3. Paper mulch. These have been around for some time, but are becoming more widely available now
4. Own mulch. Many people use natural materials generated on site as mulches. Of the 72 people that took part, 16 used bark chips, 8 used grass clippings, 8 used green waste compost and 16 used cardboard. It is not possible to make direct comparisons between the data collected at these sites and the other treatments, because they came from a different range of sites, but some general observations and comments can be made.

## **Methods**

Onion sets of the variety Centurion, were grown, either as a control without a mulch, or using woven mulch, biodegradable mulch, paper mulch or own mulch. The plots were assessed for the ground cover and types of weeds once a month.

Hand weed control took place in all plots, after the monthly weed assessment to avoid the control plots becoming completely overrun with weeds. The time spent weeding was recorded.

In mid-August, when onions were ready, a harvest was taken and number and weight of bulbs recorded. At the time of harvest, the degradation status of the mulches was recorded. The incidence of pests and diseases was also recorded during the growing season.

## **Results**

### **Mulches had little effect on how quickly the plants emerged**

The onions took about 11 days to emerge after the sets were planted. The treatments had no noticeable effect on the time to emerge. As the effect of mulches on soil temperature can be mixed, having a warming effect in the winter, and a cooling effect in the summer (Arora *et al.*, 2011, Pramanik *et al.*, 2015) this lack of effect is not surprising. In fact, there have been some instances, where a mulch can delay warming up the soil, and delay emergence (Chen *et al.*, 2013)

### **Mulches reduced weed growth substantially**

Plots were weeded directly after their monthly assessments. In the control plots, the ground cover of weeds built up to around 20% before weeding in May, June, July and August but the woven, biodegradable and paper mulches, kept the ground cover of weeds below 5% (Figure 1). There was little difference in weed growth between the 3 different mulches.

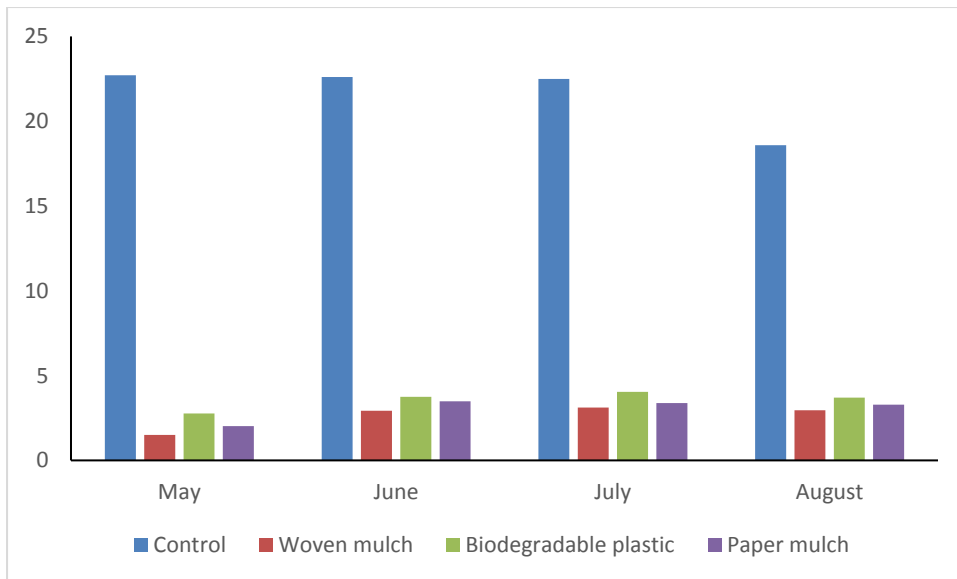


Figure 1 Ground cover of weeds under various mulches

Where people used their own mulches, cardboard successfully kept weeds below 2%, but the loose mulches such as bark chips and grass clippings only slightly reduced the ground cover to around 17%.

Natural mulches generated on site such as woody waste or compost are preferable to any plastic or manufactured mulch from an environmental and cost point of view. Their effectiveness at weed control depends on a number of factors including the type of material and how thickly it is applied. Boyhan *et al.* (2006) found that natural mulches such as straw and compost were effective for initial weed control in onions, but later in the season, the weeds grew through them. Bark mulches have shown to be effective at a thickness of 7.5 cm, reducing weed ground cover by around 50-70% (Greenly and Rakow, 1995) with thicker mulches reducing weed ground cover further up to a thickness of 15cm.

### **Annual meadow grass, chickweed and fat hen were the most common weeds**

Annual meadow grass (*Poa annua*), chickweed (*Stellaria media*) and fat hen (*Chenopodium album*) were the most common weed types found in unmulched plots. Annual meadow grass is one of the easier grasses to remove, as it doesn't have such an extensive root system as perennial grasses. Chickweed, although ubiquitous is very easily removed. Fat hen is the most vigorous weed, quickly growing into a tall plant that can set prolific numbers of seeds.

Bindweed (*Convolvulus spp.*) was the most frequent weed found in mulched plots. It can form a dense underground network of stolons and due to its growth habit, it is able to grow through the plant holes then encroach over the surface of the mulch.

### **Mulches increased yields**

All three mulches resulted in an increase in yield of 6-13% and an increase in size of 12-13% (Table 1).

For much of the season, from June to July, there was little rainfall, so the mulches may have retained some soil moisture allowing greater bulb swelling. It also reduced competition from the weeds, and may have warmed the soil early in the season, speeding up earlier growth.

Table 1 Yields of onions

Yields of onions per plot (g)

	Control	Woven mulch	Biodegradable plastic	Paper
Average	1276	1450	1348	1416
%change	-	14	6	11

Weights of onions (g)

	Control	Woven mulch	Biodegradable plastic	Paper
Average	134	151	150	150
%change	-	13	12	12

### **Mulches increased slug numbers slightly**

There was a slight increase in slug numbers under the mulches, but this was small. Slug numbers were generally low during the growing season owing to dry weather from April to June. In a wetter season, there may have been more slugs dwelling close to the soil surface, and the mulch may have caused a more significant increase in slug number. This is consistent with other findings. A trial conducted by the RHS (2017) showed that some mulches, such as bark, which has traditionally been used as a barrier against slugs, actually had the opposite effect, resulting in more slug damage. The mulch allows the soil to remain damper for longer, and provides a shelter, so that the slugs can remain close to the soil surface causing damage to the plants.

### **Mulches substantially reduced the time needed for weeding**

As it was such a dry season, little time was needed to keep the plots clear of weeds. However mulches did significantly reduce the total average time weeding from 45 minutes to 10 minutes. In a wetter season, where there would be a much higher pressure from weeds, we might expect the effects of the mulches to be significantly more marked.

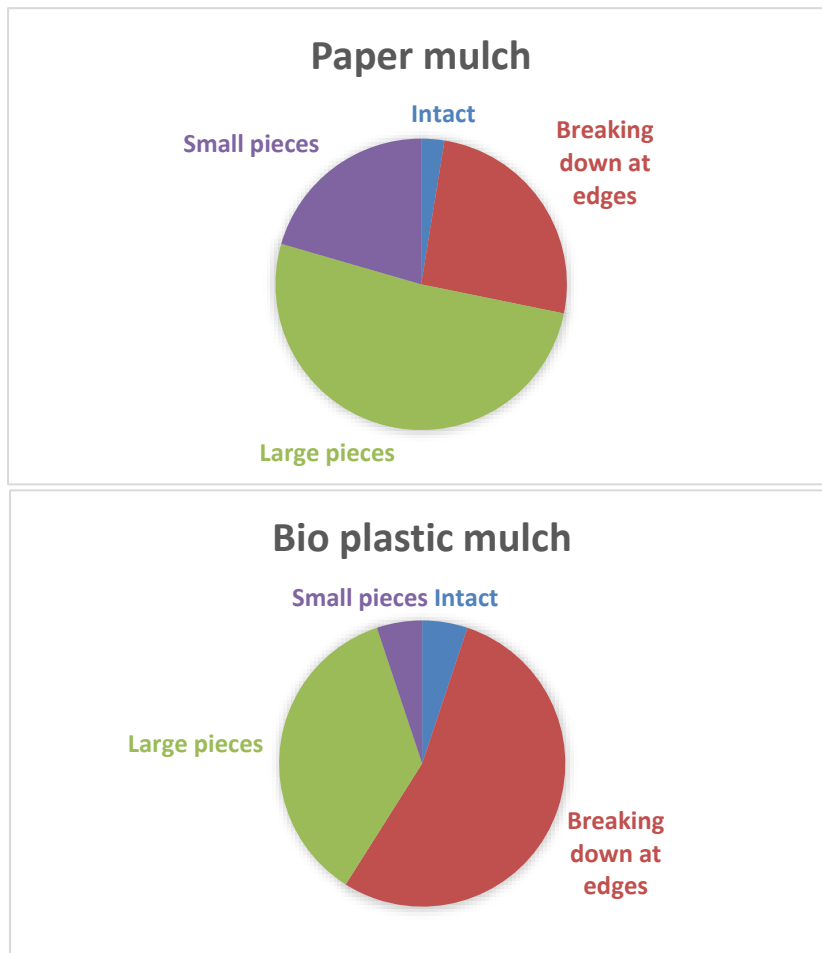
### **Paper mulch broke down most quickly**

As expected, the woven plastic mulch was still intact at the end of the season, with only 3% of participants noticing break down just at the edges.

The paper mulch showed the most break down with around 50% noticing it starting to break into large pieces. The biodegradable plastic mulch was slower to break down, with around 50% noticing it start to just break down at the edges (*Figure 2*). The manufacturers of a similar biodegradable mulch product state that the material breaks down completely in 36 months, which some may consider too long. There may also be concerns over the

toxicity of the mulches as they break down in the soil. There have been few studies on this, but recent work (Zimmerman *et al*, 2020) suggests that bioplastics may contain just as many toxic components as conventional plastics.

Figure 2 Break down of paper and bio plastic mulches



### **Paper mulches were most popular**

Woven mulches were considered a durable option that was easy to lay, but didn't allow for expansion of the bulbs. There were concerns over the plastic fibres being shed into the soil when they were cut.

The bio plastic mulch was considered flimsy and difficult to lay. There were conflicting reports about how well it allowed for expansion of the bulbs. There was also concern over the amount of energy used to manufacture the product if it was only going to have a single use. It also only started to break down slowly, and people were concerned how quickly it would break down in the soil or compost heap, and whether it contained substances that would have an adverse effect on the soil.

Paper mulch seemed to be the most popular choice. It was easier to lay and people could see that it was starting to break down by the time it came to harvest.

Of the homemade mulches, cardboard was successful at suppressing weeds, but the loose mulches such as woodchips and grass cuttings had limited effect.

### **Biodegradable mulches are more costly over a longer period**

Manufactured biodegradable mulches worked out considerably more expensive than using a weed fabric, as they need to be replaced every year. The table below compares the prices assuming that the weed fabric can be reused for 5 years. The paper mulch was the most expensive, but also the most popular to use, and raised less concerns over the environmental impact of it breaking down in the soil.

Table 2 Cost of mulches

Material	Cost (/m <sup>2</sup> ) for 1 year	Cost (/m <sup>2</sup> ) for 5 years
Weed fabric	£1.30 - £1.50	£1.30 - £1.50
Bio plastic mulch	£1.60	£8.00
Paper mulch	£1.60 - £2.40	£8.00 - £12.00

### **References**

Agassi, M., Levy, G. J., Hadas, A., Benyamini, Y., Zhevelev, H., Fizik, E., ... & Sasson, N. (2004). Mulching with composted municipal solid wastes in Central Negev, Israel: I. effects on minimizing rainwater losses and on hazards to the environment. *Soil and tillage research*, 78(1), 103-113.

Arora, V. K., Singh, C. B., Sidhu, A. S., & Thind, S. S. (2011). Irrigation, tillage and mulching effects on soybean yield and water productivity in relation to soil texture. *Agricultural Water Management*, 98(4), 563-568.

Boyhan, G. E., Hicks, R., & Hill, C. R. (2006). Natural mulches are not very effective for weed control in onions. *HortTechnology*, 16(3), 523-526.

Chen, S., Zhang, X., Sun, H., & Shao, L. (2013). Cause and mechanism of winter wheat yield reduction under straw mulch in the North China Plain. *Zhongguo Shengtai Nongye Xuebao/Chinese Journal of Eco-Agriculture*, 21(5), 519-525.

Greenly, K. M., & Rakow, D. A. (1995). The effect of wood mulch type and depth on weed and tree growth and certain soil parameters. *Journal of Arboriculture*, 21, 225-225.

Ji, S., & Unger, P. W. (2001). Soil water accumulation under different precipitation, potential evaporation, and straw mulch conditions. *Soil Science Society of America Journal*, 65(2), 442-448.

Lal, R. (1974). Soil temperature, soil moisture and maize yield from mulched and unmulched tropical soils. *Plant and soil*, 40(1), 129-143.

Pramanik, P., Bandyopadhyay, K. K., Bhaduri, D., Bhattacharyya, R., & Aggarwal, P. (2015). Effect of mulch on soil thermal regimes—a review. *International Journal of Agriculture, Environment and Biotechnology*, 8(3), 645-658.

RHS (2017) Organic slug control proves itself, taken from <https://www.rhs.org.uk/science/science-blogs/science/June-2017/slug-pellet-trial> accessed 19/04/2021

Zimmermann, L., Dombrowski, A., Völker, C., & Wagner, M. (2020). Are bioplastics and plant-based materials safer than conventional plastics? In vitro toxicity and chemical composition. *Environment International*, 145, 106066.