Comparison of Different Mulching Methods for Weed Control in Organic Green Bean and Tomato

L. Radics and E. Szné Bognár
Szent István University, Faculty of Horticultural Science
Department of Ecological and Sustainable Production Systems
Budapest
Hungary

Keywords: green bean, paper mulch, plastic mulch, straw mulch, tomato, weed management

Abstract

Recently, herbicide free weed control methods in Hungary are getting more attention due to environmental and ecological factors. Vegetable production requires good weed management Mulching provides weed control and reduces evaporation. Eight types of mulches were examined for weed control and their effects on green bean and tomato yields. We used weedy, hoed and herbicide treated plots as control during 2000 and 2001. The weather conditions were significantly different in these two years. In extremely arid year 2000, plastic sheet, paper mulch and straw mulch showed the best results in weed control and tomato yield and were significantly different from the yield of herbicide treated and hoed control plots. In humid year 2001, the use of plastic sheet, paper mulch and grass clippings caused the lowest weed cover however highest yield were in paper mulched plots. As for green bean, in 2000, weed control was higher in plastic sheet, paper mulch and straw mulch treated plots but was not significantly different from those in control treatments. At the end of growing season in 2001 high weed cover was observable in every treatment except paper mulched and hoed plots. We found no significant difference between green bean yields of different plots in both of the years. After experiences of the two years under above-mentioned circumstances compost and legume clipping were unsuitable for mulching. Mowed weeds showed negative results too. In these treatments high weed cover and low yield were noticeable in both years.

INTRODUCTION

During 1901 and 1950 rainfall in Hungary decreased significantly whereas annual average temperatures increased slightly. This phenomenon radically modifies sustainability and successfulness of farming habits, which were accommodated to climatic conditions through many years. One possible solution is decreasing evaporation with soil covering, which is also a weed management method. Partly because of environment protection and partly because of ecological farming there is more and more attention on herbicide free weed control in Hungary. Mechanical and physical weed management methods that are widespread in ecological farming have significant expenses, so we need to examine other methods under local circumstances to save expenses.

We can use living plants, plant residues (straw, compost, mowed grass, processing by-products) and industry-origin materials (black polyethylene foil, paper, felt, different kinds of textile) as mulch. Each mulching material has different weed control effect. Black foils is one of the most standby methods for weed control but as its disadvantage we have to mention that we have to remove if it is a non-degradable foil. Environmentally friendly, degradable mulch is paper. It is pervious and after turning under at the end of growing season it is biodegradable. In West Europe organic mulch is prevalent. Grass, leafage, straw and mowed weeds are used for inter-row covering.

Besides its shading effect it can provide nutrients to the soil. One of the most former mulches is straw, by-product of plant production. In Indian, straw mulch increased yield of crop and water keeping capacity of the soil (Moitra et al., 1996). According to Tu

Proc. XXVI IHC – Sustainability of Horticultural Systems
Eds. L. Bertschinger and J.D. Anderson
Acta Hort. 638, ISHS 2004
Publication supported by Can. Int. Dev. Agency (CIDA)

et al. (2001.) straw mulch is not advisable for controlling of perennial weeds, because these plants accumulate much nutrient and break through the covered surface easily. Otherwise in the case of cirsium (*Cirsium arvense*) thick straw mulch decreased the number of flowering plants.

According to Agele et al. (1999, 2000) grass clipping mulch improve yield of tomato and water keeping capacity of the soil according to uncovered control. It increased the amount of water in the top 5 cm of the soil and decreased soil temperature in the top 5 cm. In the case of late planted tomato they reached faster growing and higher yield with mulching before drought came.

By using the results of this experiment we will be able to set up a system, which is suitable for weed control, helps to protect soil structure and water content and encourages soil life. This production system could mean alternative solution for production under arid circumstances, and could avoid watering and its disadvantages.

MATERIALS AND METHODS

Ecological Circumstances

Soil type is restrainedly deep chernozem-like sandy soil. Soil forming rock is calcareous sand. Depth of humic layer is 30-40 cm. Soil is fast warmer, with good water permeability and good air capacity. The disadvantage of this soil type, it is inclined to quick cooling down and drying out, weakly calciferous, faintly alkaline soil.

Green beans were sown in first week of May. Each treatment was established on 10 m^2 parcels, beans were sown by 40 x 25 cm with 3 seeds per each pit. The test plant was dwarf beans, the variety was: Cherokee. Tomato was planted in second decade of May. Each treatment was established on 10 m^2 parcels, tomatoes were planted by 70 x 60 cm. The test variety was: Dual (half determinate).

All the 11 treatments were carried out in 4 replications.

Treatments

1) weedy control
2) herbicide control:
   solved into 4 l water into the all 4 repetitions:
   – 9 ml Olitref (before sowing) and 8 ml Dual 960 EC (after sowing)
   – in tomato: Dual 960 EC (before planting)
3) hoeing control
4) rye straw mulching with 10 cm depth
5) rye straw mulching + Phylazonit M bacteria fertiliser. Phylazonit were applied and ploughed under immediately before the straw mulching.
6) black plastic covering (fixed on the edges)
7) paper covering (fixed on the edges)
8) grass clippings mulch with 10 cm depth
9) alfalfa clippings mulch with 10 cm depth
10) compost mulching with 5 cm depth
11) mowed weeds. Permanent mowing, clipping were left on the surface

Measurements, Monitoring

– weed survey (in each month)
– dry mass of weeds
– Crop weight measuring

All the weed surveys were carried out 2 weeks after the treatments (hoeing, mowing). Test plots were the whole 10 m^2 parcels. Surveys were made in: June, July, August 3rd decade. Weed and tomato/bean cover percentage were registered. All the data were analysed with statistical tests (Tukey-test).

RESULTS AND DISCUSSION

Years of the experiment were 2000 and 2001, two years with significantly different weather conditions, so our results from these years are very important from this aspect, because of climate change effects, which increase the numbers of extremely dry, warm and humid years and we have to fit our farming habits to these effects.

Tomato 2000

All the registered data of tomato (similar to bean) were analysed in each month. Weed covering data are presented in Fig. 1.

Weed cover percentage was reduced in most treatments due to extreme dry weather in August. Weed reducing effect of straw, plastic cover, paper cover and grass clipping mulch (4, 5, 6, 7, 8) treatments was permanent during the whole season The total weed cover percentage in herbicide and hoeing control (2,3) treatments was bellow 20%. There were significant difference between 2, 3, 4, 5, 6, 7, 8 treatments and mowed weed (11) treatment in June, July; alfalfa clipping (9) treatment in August and compost mulching (10) treatment during the whole season ($SD_{5\%}$). Test plants could not utilise the nutrients of compost, because it has dried on soil surface quickly. Weeds could utilise this nutrient source better, therefore the weed cover percentage has grown in this treatment.

The weed cover percentage in mowed weeds treatment was almost the same as the weed control treatment, because the dominant weed species was *Portulaca oleracea*, which can not be controlled by permanent mowing.

We have analysed data according to life forms too.

T = Therophyta

T_1 – p*lants, which are spearing in fall and ripening in spring*

T_2 – *plants, which are spearing in fall and ripening in the beginning of summer*

T_3 – *plants, which are spearing in spring and ripening in the beginning of summer*

T_4 – p*lants, which are spearing in spring and ripening in the end of summer*

G = Geophyta (plants, which are overwintering on the soil surface or under soil and has slanting or horizontal underground stem)

G_1 - *plants, which have stoles near to the soil surface*

G_3 - *plants, which have stoles in deeper and many levels of the soil*

Weeds of T_4-life form were dominant in every treatment. Significant difference was observable in the case of treatments 9, 10 and 11 ($SD_{5\%}$).

There was no statistically certifiable difference between treatments in the case of G_3 and G_1 (perennial) weeds.

Species of G_3-life form (*Cirsium arvense*, *Convulvulus arvensis*) reached their highest covering in herbicide treated plots in June.

Measurements of dry mass of weeds showed the same results as weed surveys. Straw, plastic foil and paper mulch had the best weed suppress effect. We found higher dry mass of weeds under compost mulch than on untreated weedy control plots in July and in August as well. So we can see from this that compost made better circumstances for weeds too.

There are significant differences between yields of treatments (Fig. 2.). Both straw mulches, foil and paper mulch made statistically homogenous group. In these four treatments we measured significantly higher yield than in treatments 9, 10, 11 and in hoed and herbicide treated control ($SD_{5\%}$). In treatments 9, 10, 11 high weed cover caused the low yield. Differences between yields of hoed plots and plots of 4, 5, 6, 7 treatments originated in crop showed its gratitude for mulching in that arid year.

Tomato 2001

After extremely dry 2000 year in 2001 there was significant amount of precipitation so we could test covering materials under different circumstances.

In this year compost mulch gave negative result, this treatment showed high weed cover (Fig. 3.) during the whole growing season. Treatment 10 differed significantly

($SD_{5\%}$) from 3, 6, 7, 8 treatments during the whole growing season.

Legume clipping (9) seems to be unsuitable for mulching in this year too. Treatment 9 differed significantly ($SD_{5\%}$) from 3, 5, 6, 7, 8 treatments in July and August.

In 2001 straw, foil, paper and grass clipping mulches (5, 6, 7, 8) showed the best results. In June every four and in July foil and grass clipping mulches differed significantly ($SD_{5\%}$) from herbicide treated plots. Straw (4) and straw with Phylazonit M bacteria fertiliser (5) showed different weed cover, but this difference was not statistically certifiable. The reason for this could be the higher cover of tomato in treatment 5. Probably in this humid year bacteria fertiliser could prevail and N fixing and P mobilising bacteria increased nutriment in the soil. This could increase cover of tomato.

Weeds of T_4-life form were dominant in every treatment; these species gave the differences, which were observed in the case of total weed cover.

There was no statistically certifiable difference between treatments in the case of G3 and G1 (perennial) weeds.

Because of sufficient amount of precipitation and the high weed cover at the end of growing season there are not as big differences between the yields as in 2000 (Fig. 4.). We have measured the highest yield in paper mulched plots (7) and the fewest in mowed weeds (11) ($SD_{5\%}$). At $SD_{10\%}$ paper mulch was significantly better also than herbicide treated control.

The highest weed cover was not in treatment 11 (cover of 9, 10 was higher) but the lowest yield was observable here. This could have two reasons, on the one hand in treatment 9, 10 legume clippings started to decompose and gave nutrient for the crop. On the other hand mowed weeds meant probably high concurrence for the crop.

Measurements of dry mass of weeds showed the same results as weed surveys. Weed suppressing effect of plastic foil, paper and cut grass was observable in whole year.

Green Bean 2000

In foil covered plots bean emerged one week before the ones in other treatments. Under warm and arid circumstances of 2001 black foil ensured suitable conditions for seed germination. In the following humid year this difference disappeared. At the end of the growing season in legume clipping and in compost covered plots weeds were dominant (Fig. 5.) and this difference was statistically detectable. Measurements of dry mass of weeds showed too that these two mulching methods were not suitable for suppressing of weeds under these circumstances. Mowing of weeds reduced weed cover slightly.

Significant differences ($SD_{5\%}$) were in June between 9, 11 and 2, 3, 5, 6 treatments and in July between 9, 10 and 2, 3, 4, 6, 7 treatments. There was no statistically certifiable difference between covered and uncovered plots.

Weeds of T_4-life form were dominant in every treatment. There was no statistically certifiable difference between treatments in the case of G3 and G1 (perennial) weeds.

There was no significant difference observable between yields of green bean. We measured the highest amounts in plastic and paper covered plots. In treatments 9, 10, 11 showed the lowest yields so in these plots weed cover beyond the critical level which manifested in yields. If we compare these yields with the yields of tomato, we can conclude that tomato showed better reactions to covered soil surface.

Green Bean 2001

In 2001 at the end of the growing season there was high weed cover in every treatment except plastic and paper mulched ones (Fig. 6.). In June weed cover only of treatment 11 differed significantly ($SD_{5\%}$) from the other treatments. The reason was probably that in this treatment rate of *Amaranthus blitoides* weed species was high. This species do not grow high but cover a relative big area. In July compost was significantly ($SD_{5\%}$) different from paper and plastic.

Straw (4) and straw with Phylazonit M bacteria fertiliser (5) showed different weed cover, but this difference was not statistically certifiable. The reason for this could

be the higher cover of green bean in treatment 5. Probably in this humid year bacteria fertiliser could prevail and bacteria increased nutriment in the soil, which could increase cover of tomato.

Weeds of T_4-life form were dominant in every treatment. There was no statistically certifiable difference between treatments in the case of G_3 and G_1 (perennial) weeds.

Weed control effect of plastic and paper was not observable in the yields of green bean. In humid year 2001 there was no significant difference between yields of the treatments.

CONCLUSIONS

The following conclusions can be deduced from this study under the variable extreme climatic conditions of 2000 and 2001:

- The best results for weed control were found in plastic covering and paper covering treatments in tomato and bean tests in both dry and humid weather conditions.
- Tomato yield was significantly ($SD_{5\%}$) higher in plastic covering and paper covering treatments than in herbicide and hoeing control treatments in dry weather conditions. These differences were not observable in humid weather conditions. The advantage of paper covering comparing to plastic is the paper do not pollute the environment and the maintenance is easier at the end of growing season, when the paper can be simple ploughed into the soil, because it is a biodegradable material.
- Straw and straw+Phylazonit treatment could give positive weed control effect in dry weather conditions (2000.) in tomato and bean tests. We measured the second high yield in tomato in the straw-mulched parcels after the plastic covering treatments. We could find differences between straw and straw+Phylazonit bacteria fertiliser treatments in yield and covering of test plants only in humid weather conditions, but it was not significant.
- Grass clipping can be suitable mulch, because it gave better result on yield and covering of test plants than alfalfa covering.
- On the basis of this two years we did not find acceptable mulching effect in tomato and bean tests in case of compost and alfalfa clipping under the prevailed climatic conditions.
- We did not find positive result in mowed weed parcels. High weed cover percentage were found and reduced yield in these plots in tomato and bean tests as well.
- Measurements of dry mass of weeds showed the same results as weed surveys.
- Comparing the yield of bean we did not find any significant difference among the treatments in the yield of bean in any year.

Long-term experiments are needed to evaluate the effects of climatic conditions on weed management in tomato and green bean.

ACKNOWLEDGEMENTS

Research was supported by the Ministry of Agriculture and Rural Development.

Literature Cited

Agele, S., Iremiren, G. and Ojeniyi, S. 1999. Effects of plant density and mulching on the performance of late-season tomato (*Lycopersicon esculentum*) in southern. Journal of Agricultural Science 133: 4, 397-402.

Agele, S., Iremiren, G. and Ojeniyi, S. 2000. Effects of tillage and mulching on the growth, development and yield of late-season tomato (*Lycopersicon esculentum*) in the humid south of Nigeria. Journal of Agricultural Science 134: 1, 55-59.

Moitra, R., Ghosh D.C. and Sarkar, S. 1996. Water use pattern and productivity of rainfed yellow sarson (*Brassica rapa* L. var glauca) in relation to tillage and mulching. Soil and Tillage Research, 38, 1: 153-160 (8)

Smith, A.E. 1995. Handbook of Weed Management Systems. 557-558. New York, USA.

Tu, M., Hurd, C. and Randall, J.M. 2001. Weed Control Methods Handbook, The Nature Conservancy, http://tncweeds.ucdavis.edu, Version: April 2001.

Figures

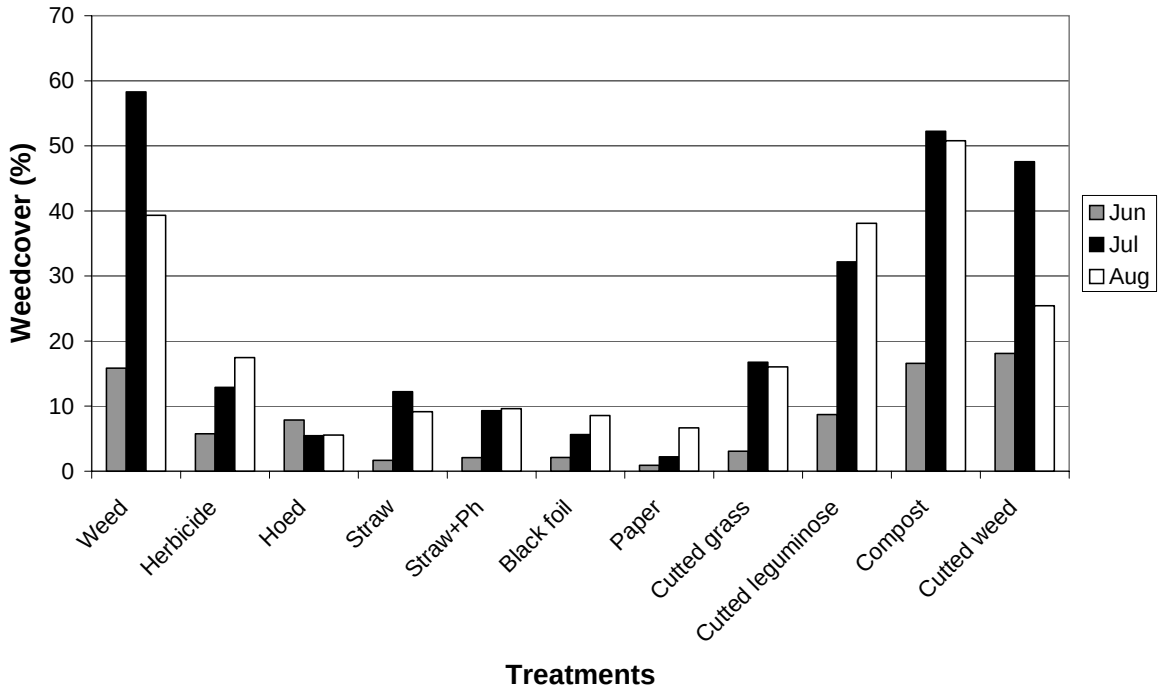

Fig. 1. Weed cover in 2000 in tomato.

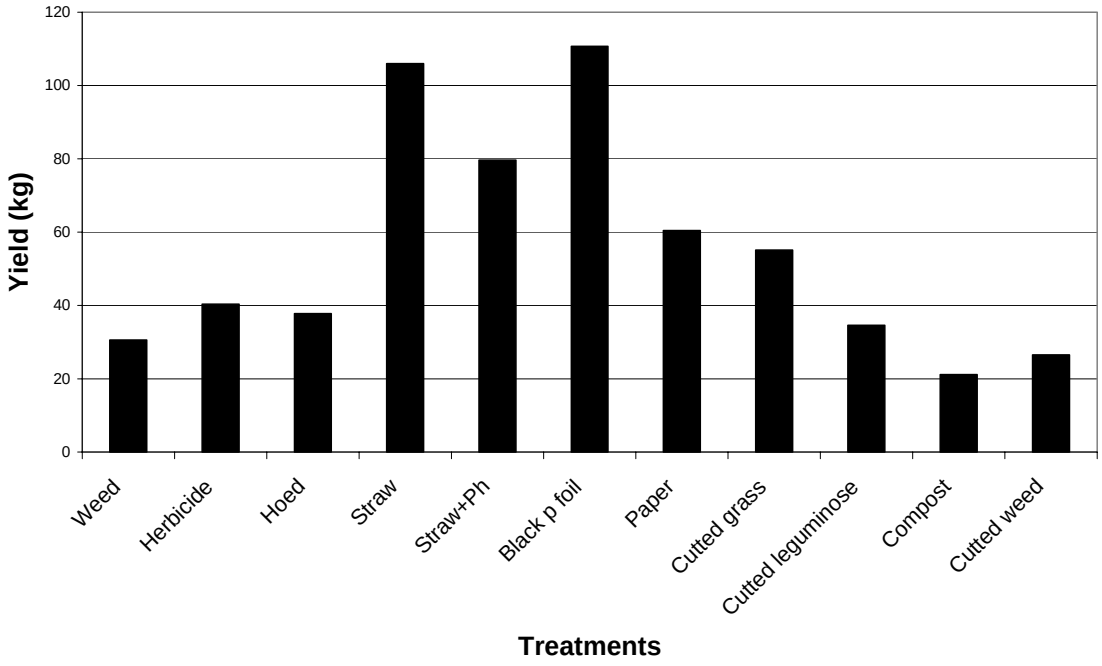

Fig. 2. Yield of tomato in 2000.

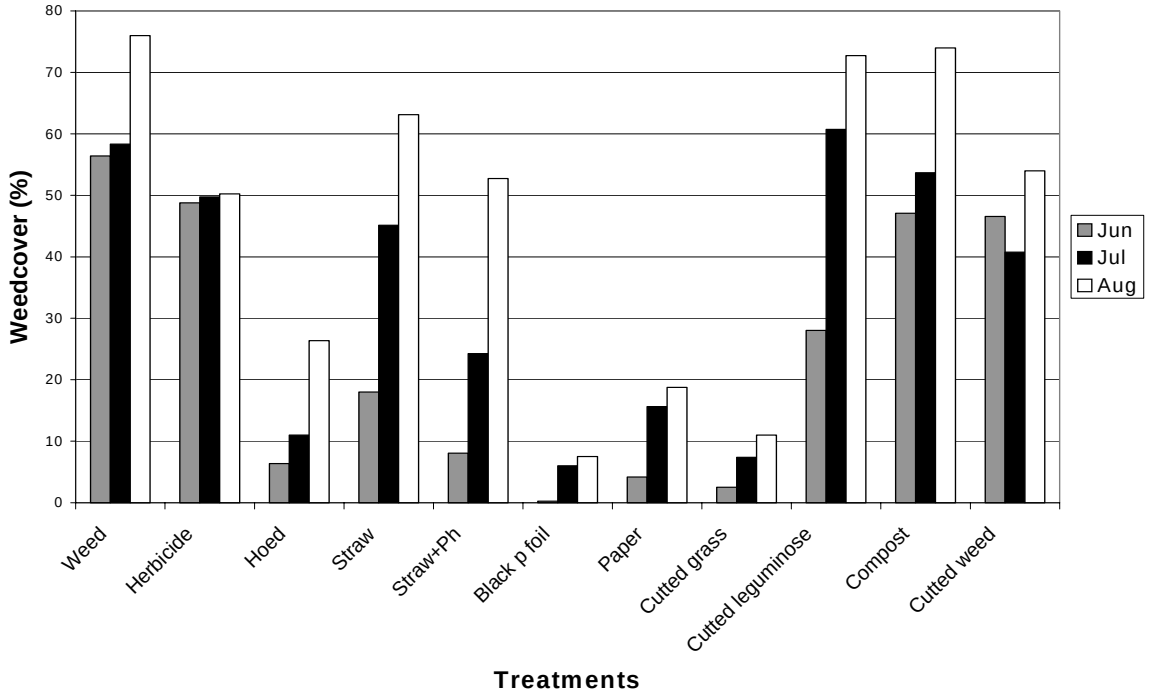

Fig. 3. Weed cover in tomato in 2001.

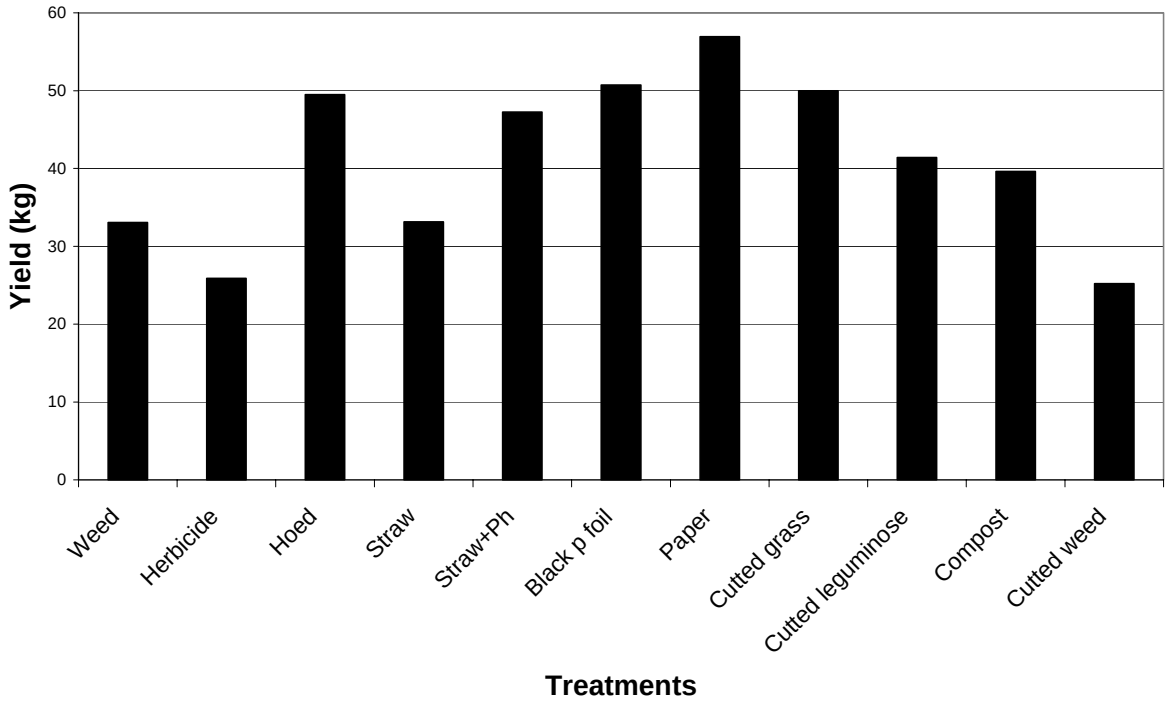

Fig. 4. Yield of tomato in 2001.

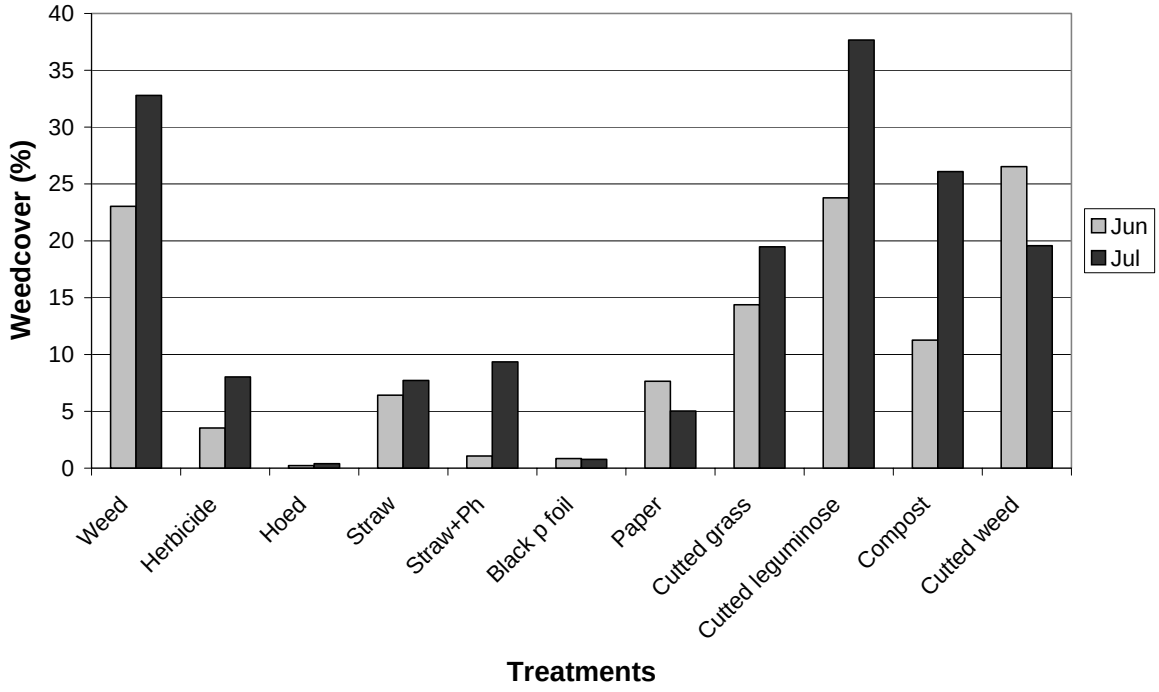

Fig. 5. Weed cover in green bean in 2000.

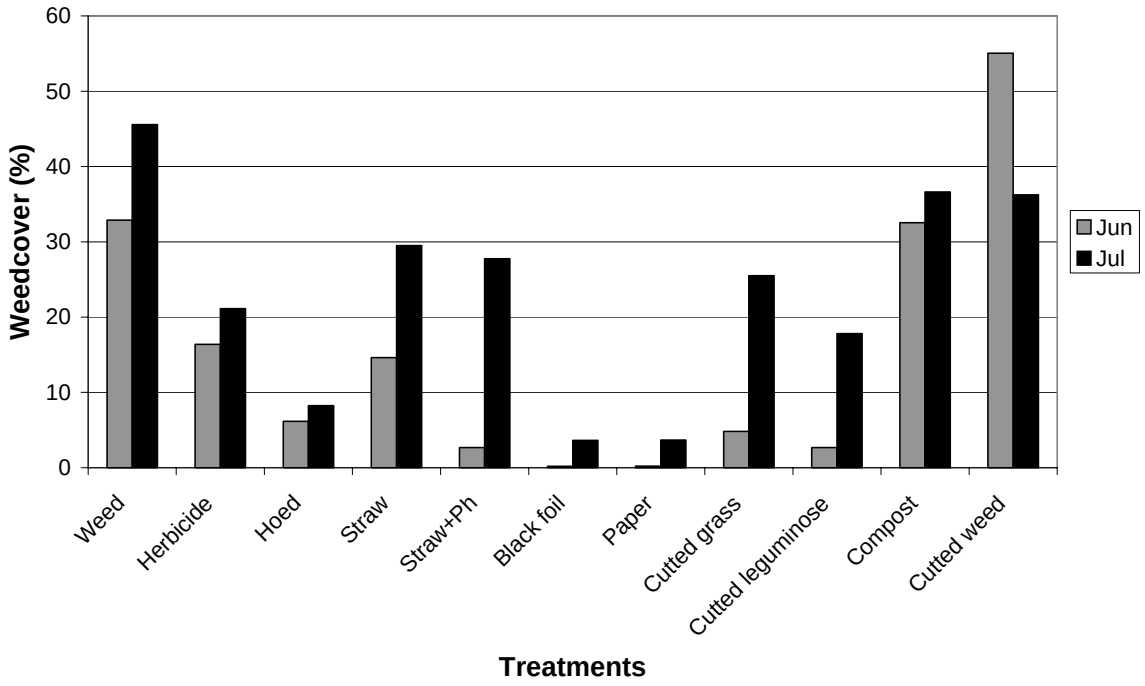

Fig. 6. Weed cover in green bean in 2001.