

IMPACT: CROP YIELD

Reference 2

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Background and objective

An important management strategy for the development of sustainable agriculture in orchards is the management of ground cover. However, there is a knowledge gap regarding the effects of ground cover on fruit yield and quality. The objectives of this study were to quantitatively evaluate: (a) the overall effectiveness of ground cover management on fruit yield and quality indicators; and (b) the effectiveness of ground cover management based on climatic condition, fruit tree species and ground cover types. The aim of this study was to provide evidence-based means to improve fruit yield and quality using more sustainable management practices.

Search strategy and selection criteria

Using the Web of Science database and the China National Knowledge Infrastructure, we searched journal articles published from July 1987 to March 2020 that reported ground cover in orchards. The search terms included 'ground cover', 'cover crop', 'mulch', 'green manure', 'catch crop', or 'sod cultivation' and 'orchard', 'fruit tree', or 'fruit'. (a) at least one of the targeted fruit tree variables (yield and quality indicators) was reported under both ground cover management and clean tillage (bare soil) management; (b) only field studies were chosen; (c) only the latest observations were taken to meet the standard of independence of samples, when variables were measured at multiple time points; (d) multiple ground cover management types, cover crop species, fruit tree species, cultivation durations, and tree ages in one study were considered as independent observations.

Data and analysis

Natural logarithm transformation was conducted to improve the statistical power by lowering the estimated bias and normalizing the sample distribution. A weight factor (ω) was estimated for each study. If the variance of the mean value was not reported in some studies, the weight factor was estimated. The mean effect size of each given variable was calculated. The percentage of changes (C%) of the investigated variables induced by ground cover were calculated. A normality test of RR for each variable was conducted using the Kolmogorov-Smirnov test. We found that most variables did not follow a normal distribution. The nonparametric bootstrap analysis (resampling $n = 10,000$ iterations) was calculated by SPSS V20.0 (IBM, Chicago, USA).

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
116	fruit tree species (apple, citrus, grape, jujube, kiwi fruit, peach, pear, plum)	Ground cover (including cultivated green manure, sod cultivation, natural, vegetation, grass, and cover crop)	Clean tillage management	Metric: Fruit yield; Effect size: Logarithm of ratio of the considered metrics in the intervention to the considered metrics in the control	68.75

Results

- When separating ground cover type into mulch and cover crops, mulch significantly increased fruit yield (C%: 26.42%), while no benefit to fruit yield from pooled cover crops was observed. However, legume cover crops significantly increased fruit yield by 8.99%, while non-legume cover crops significantly reduced fruit yield by 11.30%. Legume cover crops had a significant impact on weight per fruit (C%: 6.77%), and this impact was greater when the grass age was less than 3 years. Non-legume cover crops had no effect on fruit weight.
- Mulch had no significant effect on weight per fruit, but the use of cover crops significantly increased this response variable by 4.95%.
- Across all of the study sites covered by this meta-analysis, ground cover management in orchards significantly increased the fruit yield (Number of experiments = 395) and weight (Number of experiments = 227) per fruit by 6.98% and 5.86%.
- Soluble solid content, sugar content, and vitamin C content were significantly enhanced by 6.77%, 7.83%, and 14.59%, respectively.
- When pooling data into different fruit tree species, ground cover significantly increased the yield of apples, jujubes, and peaches by 10.13%, 49.21% and 7.20%. Ground cover significantly increased the weight per fruit of apples (C%: 57.61%), jujubes (C%: 19.63%), peaches (C%: 107.09%) pears (C%: 11.11%) and plums (C%: 11.80%).

Factors influencing effect sizes

- Climate zone : Ground cover significantly increased fruit yield compared with clean tillage treatment when the climate zone under subtropics (C%: 2.18%) or temperate (C%: 6.98%) and humid zone (C %: 14.56%)
- Fruit tree age : Ground cover significantly increased the fruit yield (C%: 7.71%–11.21%) only when fruit trees were older than 5 years.

Conclusion

Cover cropping with legumes induced significant improvements in fruit yield and weight of fruits. Non-legume cover crops were not effective for weight of fruits and had negative effect on fruit yield.