Organic farming of pea in the northern hemisphere – a review

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Abstract

Pea (Pisum sativum L.) is a major human food crop. During the past two or three decades there has been a change towards organic cultivation. The aim here is to overview the main research results of the pea organic farming system to improve practices by farmers in northern hemisphere. Biofertilizers applied together with organic manures increase the yield of peas. Weeds can be reduced by the following methods: mulching, pre-emergence mechanical weed control at pre-emergence, harrowing in the early growth stages, a single pass of tine weeding either at pre-emergence or at the 2-leaf stage of the crop. On some occasions, two passes of the tine may be required to control new weed emergence. Pea varieties that grow fast and accumulate biomass (high seed weight cultivars) compete better with weeds. Foliar application of effective microorganisms with proper soil amendment and seed inoculation with Rhizobium coupled with soil application of organic manures can increase yields. Application of organic manures, irrespective of sources and rates, reduce the incidence of wilt. Choice of the right cultivar for organic cultivation is very important, but depends on local agro-climatic conditions. The chemical content of peas varies with different conditions.

Keywords: Pisum sativum L., chemical composition, growth, organic farming, plant protection, cultivars, yield

INTRODUCTION

Pisum sativum L. (field or garden pea), is a domesticated plant cultivated in Europe since ancient times (Taranovs, 1968). It is an herbaceous annual in the Fabaceae (formerly Leguminosae) family, originating from the Mediterranean basin and Near East, but now widely grown for its seed. It is a major human food crop; green pea production worldwide in 2011 was 17 Mt (FAOSTAT, 2013).

Peas are widely consumed due to their high nutritional value. They contain fiber, protein, vitamins (folate and vitamin C), minerals (iron, magnesium, phosphorus and zinc), and lutein (a yellow carotenoid pigment that benefits vision) (Issako, 1989).

From the second half of the 19th century growers around the world successfully developed and refined farming systems that relied on synthetic biocides or inorganic fertilizers. However, during the past two decades there has been a change once more towards organic cultivation (Olle and Williams, 2013).

The key factors affecting consumer demand for organic food is health consciousness and the willingness of the public to pay for high-quality high-priced produce. In general, consumers of organic products are an affluent, educated, and health conscious group spurred by strong consumer demand, generous price premium, and concerns about the environment. Because of these benefits, conventional growers are turning to organic farming. In Europe, government policies aim to stimulate the organic sector through subsidies, consumer education, and support in the form of research, education, and marketing (Yadav et al., 2013).

Since there is an increasing interest in organic farming of vegetable crops, the aim here is to review the main research results of the pea organic farming system to improve practices by farmers in northern hemisphere.
EMERGENCE, FERTILIZER APPLICATION AND NUTRIENT CONTENT OF PEAS

Faster emergence (20% after 14 days after planting compared to control) of pea seeds and reduced severity of damping-off has been obtained by combining seed priming (16 h) with biochar as a desiccant followed by Nordox an organic cuprous oxide seed treatment (Alcala et al., 2013). This faster emergence and reduced damping-off could translate to greater pea yields.

Application of biofertilizers containing native field Rhizobium strains can greatly enhance pea yield (Agrawal and Choure, 2011). Trials with farm yard manure and vermicompost, and dual inoculation with biofertilizers in different combinations, have shown that both Azotobacter and PSB (phosphorous solubilising biofertilizers e.g. Bacillus sp., Pseudomonas sp. and Aspergillus spp.), play a major role in increasing nutrient availability to the plants, which in turn is reflected in better quality of the produce and yield maximization. The biofertilizers, however, showed better responses when applied together with organic manures, since the manures provided a favourable environment for their activity (Sharma and Chauhan, 2011).

Increased pod yield (181.5 and 166.2%) over a control treatment of no fertilizer has been achieved with the application of farmyard manure at 20 and 15 t ha⁻¹ respectively (Pandey et al., 2006). Mahmoud et al. (2013) reported that using compost and spraying pea plants with yeast extract solution at 2% improved vegetative growth and pod yield, and Mourão et al. (2013) reported that soil application of compost at a rate of 30 t ha⁻¹ increased greenhouse grown organic pea yield. Determining the optimum compost rate that can be applied and ensuring sufficient nutrients are supplied to the crop that are comparable to chemical fertilizers is a next step to improve organic production.

Foliar application of effective microorganisms in combination with proper soil cultivation has improved nodulation and yield in pea (Javaid, 2006). When used with an NPK fertilizer application effective microorganisms increased nodule number by 217% and nodule biomass by 167%, but this effect was not prevalent with compost application. However, when a green manure was incorporated into the soil and a foliar application of effective microorganisms made, grain yield increased by 145%, whereas with NPK amendment grain yield increased by only 126%. A similar results was found by Singh et al. (2011), where seed inoculation with Rhizobium coupled with soil application of organic manures, particularly vermicompost (10 t ha⁻¹) enhanced most of the growth and yield attributes in garden pea.

Not only yield, but also the nutritional value of pea grains is strongly influenced by soil nutritional conditions. Singh et al. (2011) reported that the highest protein content in edible pea grains (26.1%) was measured when standard NPK fertilisers were used. However, the highest vitamin C content in pea pods was obtained when grown with different organic manures and fertilisers, the exceptions being sole applications of vermin-compost or poultry manure. The highest vitamin C content in pods was observed with combined application of vermicompost and phosphate solubilizing bacteria (6.54 mg 100 g⁻¹) (Singh et al., 2011).

Yields are influenced by seasonal climate conditions and farming system; in 1998-2007 higher yields were obtained in the conventional system than in the organic system (Marta and Lehocka, 2009). The influence of adequate nutritional supply from organic soil amendments for pea growth should be further investigated to help improve yields in organic systems.

PLANT PROTECTION

Organic farming demands appropriate and timely plant protection measures. Weed control is one of the challenges and mulches are often used. Bakht et al. (2009) demonstrated that some mulches were more efficient in controlling weeds in pea than others; polyethylene (black) and newspaper mulches gave better results than wheat straw, saw dust, and white polyethylene mulches.

Johnson and Holm (2010) investigated pre-emergence mechanical weed control in field pea. They described that a strategy for field pea producers who choose not to use herbicides would be to delay seeding until some weeds emerge and to sow at a 7.5-cm depth
followed by two sequential rod-weeding passes prior to crop emergence. The uprooting
effect of harrowing has been shown to be more important for weed control at early growth
stages of crops than at later stages; crop damage by harrowing was less at the late post-
emergence (beginning of stem elongation) stage (Velykis et al., 2009).

Significant weed control was achieved with a single pass of tine weeding either at pre-
emergence mechanical weed control in field pea, in early growth stages of pea crops the
harrowing, pre-emergence or at the 2-leaf stage of the crop, while on some occasions two
passes of a tine were required to control new weeds (Dastgheib, 2004).

Application of organic manures, irrespective of sources and rates, gave significant
reduction in the incidence of wilt (Fusarium oxysporum f. sp. pisi) on peas (Pandey et al.,
2006). In contrast the control of Pythium ultimum or Rhizoctonia solani seems to depend on
the amount of compost added. In pot experiments under controlled environmental
conditions the addition of 8, 10 and 30% composted household waste to the potting material
which was artificially infested with Pythium ultimum or Rhizoctonia solani considerably
reduced the incidence of disease in different cultivars of peas. The degree of protection
provided by compost depends upon the amount of compost added and upon the
vulnerability of the host plant to infection (Schüler et al., 1989). There seems considerable
scope for establishing approaches to improve control of soil borne diseases using
appropriate organic compost additions to soils.

CULTIVARS

Genotype has significant influence on plant habit and consequently on the weed
suppressing ability by biomass. Field experiments in Denmark during 1997, 1998 and 2000
showed the effects of genotype and sowing rate on the competitive ability of green pea crops
against weeds in organic production. The cultivars with high biomass accumulation
(Ambassador, Greenshaft, Jaguar, Zelda and DS8903) were highly competitive against weeds
while the small-sized pea cultivars (Dinos, Argona and Wizard) had low competitive ability
against weeds and were unsuitable for organic pea production. Pea cultivars that grow fast
and accumulate biomass (high seed weight cultivars) are better at competing with weeds
(Greven, 2003). Similarly, increased pea sowing rate improved weed suppression
(Munakamwe et al., 2012). Most common pea sowing rate is 120 emerging seeds per m²,
increasing this rate can lead to better weed suppressing ability in organic cultivation systems.

Suitability for organic farming is determined not only by the weed suppressing ability of the
cultivar, but also its ability to give high and stable yields. Several authors have
evaluated pea cultivars for organic farming. The suitability of the Latvian origin cultivars of
Pisum sativum subsp. arvense L. (pink flower cultivars) 'Retrija', 'Almara' and 'Vitra', and two
cultivars of Pisum sativum L. (white flower cultivars) 'Lāsma' and 'Zaiga', for organic farming
has been investigated (Agafonova et al., 2011). All were suitable for organic farming in
Latvian climatic conditions on sod-podzol sandy-loam soil, though the study lacked a
comparison with conventional production practices. The best yielding cultivar among white
flower cultivars was 'Zaiga' and the most productive among pink flower peas cultivars was
'Almara'. 'Retrija' was deemed best in terms of total protein content and taste (Agafonova et
al., 2011). Gopinath et al. (2009) found that of garden pea cultivars, 'Azad pea 1', 'Vivek
Matar 8' and 'Vivek Matar 9' were suitable for organic cultivation at Almora (Indian
Himalayas), though yields were lower than conventional production practices. Their
conclusions are that a price premium of 20% is needed to offset the higher cost of organic
cultivation and crop yields. In the Slovak Republic, the new cultivar 'Achat' (grown in the
years 2003-2007) had higher yields than the cultivar 'Olivin' (grown in the years 1998-
2002) under organic production, though yields were approximately 13% higher in
conventional systems than organic systems (Marta and Lehocka, 2009).

CONCLUSIONS

Biofertilizers applied together with organic manures increase the yield of peas. Higher
yields (approximately 26-82%) have been obtained by using organic manures or compost
(15-20 t ha⁻¹) for fertilization compared to no fertiliser application. Significant success in
weed control has been achieved with a single pass of tine weeding either at pre-emergence or at the 2-leaf stage of the crop. On some occasions two passes of tine have been required to control newly emerged weeds. Foliar application of beneficial microorganisms with proper soil amendment and seed inoculation with *Rhizobium* coupled with soil application of organic manures could increase yield in pea. Chemical content of peas is variable and dependent on different conditions.

Pea cultivars that grow fast and accumulate biomass (high seed weight cultivars) are better at competing with weeds (all leafy pea cultivars, for example pea cultivar Seko in 80% of cases, depends on agro-climatic conditions). Application of organic manures, irrespective of sources and rates, reduced the incidence of wilt on the pea crop.

Choice of the right cultivar of pea for organic cultivation is very important, but this depends on local agro-climatic conditions.

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**Literature cited**


