CSIRO PUBLISHING
Crop & Pasture Science, 2017, **68**, i–ii
https://doi.org/10.1071/CPv68n11_FO

Foreword

Legumes in sustainable agriculture

Sergio G. Atienza and Diego Rubiales

Institute for Sustainable Agriculture, CSIC, Alameda del Obispo s/n, 14004, Córdoba, Spain.
Emails: sgatienza@ias.csic.es; diego.rubiales@ias.csic.es

Agriculture faces unprecedented demands for food and feed production due to the increase in world population predicted for the next decades. The growing concerns on environmental and food security make necessary to face these demands with more sustainable and environmentally friendly agricultural practices which constitute a high challenge for researchers and farmers all over the world.

Under this pressing scenario, legume crops must play an important role due to their widely acknowledged beneficial roles. The nitrogen-fixing properties of legume crops have a positive impact on environment since they increase soil fertility and reduce the requirements of inorganic fertilizers. The utilization of legumes in crop rotations also allow for the mitigation of pest and diseases in subsequent crops, which help in reducing farmer costs and protecting the environment. Despite the advantages of legumes, their cultivation has not achieved the expectations and the cultivation area devoted to some legumes has declined worldwide in the last 50 years.

This special issue was conceived as an opportunity to focus attention on the role of legumes as part of sustainable food production. The timing is important since 2016 was declared the International Year of the Pulses at the 68th United Nations General Assembly (A/RES/68/231). The term pulses is restricted to crops harvested solely for dry grain as noted in the UN resolution, including beans, chickpeas, peas and lentils but the importance of legumes in agriculture transcends the production of grains since they have an increasing role as forage or they can be used as green manure.

This special issue covers significant topics including plant adaptation, agronomy, breeding, biotic & abiotic stresses and quality in both pulses and forage species. All these topics were addressed during the Second International Legume Society Conference, held in Troia, Portugal, in October 2016 and many of the articles published in this issue are related to results reported during this conference.

The opening article of this issue highlights the importance of flowering time in plant adaptation (Catt and Paull 2017). These auhors explore the variation in flowering time in faba bean in order to breed new lines with higher yield and adapted to specific environments. After this, several articles report advances in agronomy and field testing which are important to demonstrate the beneficial properties of legumes in cropping systems and for the identification of cultivars with wide or specific adaptation to different growing conditions.

Despite the beneficial role of legumes, their cultivation area is very limited compared to cereals, but the design of new cropping systems including grain legumes may contribute to increase the sustainability in European farming systems (Pelzer *et al*. 2017). The assessment of cultivars stability in different environments is an important tool to select appropriate cultivars for specific growing conditions as shown in field pea (Iglesias-García *et al*. 2017). Similarly, the existence of G×E interaction is also significant in cowpea (Martos-Fuentes *et al*. 2017) which highlights the opportunities to develop new cultivars adapted to specific sites.

Advances in agronomy and breeding of pastures have also been addressed in this issue. The performance of legume-grass mixtures and pure stands for forage production was compared in different Mediterranean drought-prone environments (Annicchiarico *et al*. 2017), which is relevant to determine the best option for forage production in each site. In the same way although grass-legume mixtures are key crops to improve agriculture sustainability the performance of cultivars may differ between monoculture and mixture cropping systems (Maamouri *et al*. 2017). These authors found significant changes in ranking of cultivars depending of the growing system, and thus they suggested that the improvement of lucerne varieties should consider both growing systems. All these findings are important for breeding and highlight the importance of identifying the purpose of new cultivars. In this context Pecetti and Annicchiarico (2017) assessed the amount of genetic variation in breeding grazing-tolerant lucerne, and found that there is large variation available although extensive evaluation is required.

Plant breeding is a slow process which requires the evaluation of large numbers of genotypes. Thus the development of new protocols allowing shorter times and higher selection efficiency are very appreciated by breeders and researchers. The new *in vitro*-assisted protocol developed by Pazos-Navarro *et al*. (2017) allowed the production of several generations per year (between 2.7 and 6.1) using subterranean clover as a case study. This achievement opens new possibilities for plant breeding and to speed up the development of mapping populations such as Recombinant Inbred Lines for genetic studies. It is well known that marker assisted selection (MAS) is useful to improve the selection efficiency, but it is important to show specific results to remind the advantages of MAS. In this context Gil *et al*. (2017) reported the effectiveness of this technique in chickpea for the

development of advanced lines with resistance to ascochyta blight and larger seed size. Similarly, breeding progress can be assessed by the evaluation of the performance of cultivars released during the last decades as shown by Qin *et al*. (2017) for soybean in China.

The identification and utilisation of new sources of resistance/tolerance to biotic and abiotic stresses is a key for success in plant breeding. Several works have addressed this topic in this special issue including a review on the effects of heat stress during grain-filling in legumes (Farooq *et al*. 2017); the identification of new sources of resistance to powdery mildew in common bean along with linked markers useful for MAS (Murube *et al*. 2017); the identification and multi-environment validations of resistance to rust in faba bean (Sillero *et al*. 2017); and the assessment of fusarium wilt resistance in lentil (Parihar *et al*. 2017). All these works emphasize the importance of the continuous effort to identify and use new sources of resistance useful in breeding.

Nutritional aspects are important in breeding legumes in two different ways. In one hand, biofortification of seeds may help to alleviate specific micronutrients deficiencies suffered in determinate world regions. On the other hand, breeding for higher quality is required for consumers for the production of healthier foods or to meet specific demands such as flavours or colours. Poblaciones and Rengel (2017) successfully biofortified field peas with zinc and selenium using combined foliar application and thus these results may help to reduce the deficiencies of both microelements. Regarding quality, Serrano *et al*. (2017) studied seed and flour characteristics in chickpea and they reported that the chickpea germplasm present a high potential for the improvement of nutritional characteristics. Similarly, Santos *et al*. (2017) also analysed the storage proteins in chickpea using proteomics with a focus in their nutritional aspects.

The last papers of this issue addressed other important topics in legume production including the effect of inoculation with arbuscular mycorrhizal fungi and nitrogen-fixing bacteria in cowpea under drought scenarios (Oliveira *et al*. 2017); the utilisation of cover crops as green manure (Ćupina *et al*. 2017) or weed response in lucerne-wheat intercrop under different cropping systems (Barilli *et al*. 2017).

Future research on all the topics covered in this special issue is a high priority and should be strengthened in order to face the new challenges of this century.

References

Annicchiarico P, Alami IT, Abbas K, Pecetti L, Melis RAM, Porqueddu C (2017) Performance of legume-based annual forage crops in three semi-arid Mediterranean environments. *Crop and Pasture Science* **68**, 932–941.

Barilli E, Jeuffroy M-H, Gall J, de Tourdonnet S, Médiène S (2017) Weed response and crop growth in winter wheat–lucerne intercropping: a comparison of conventional and reduced soil-tillage conditions in northern France. *Crop and Pasture Science* **68**, 1070–1079.

Catt SC, Paull JG (2017) Effects of ambient temperature and photoperiod on flowering time in faba bean (*Vicia faba* L.). *Crop and Pasture Science* **68**, 893–901.

Ćupina B, Vujić S, Krstić Dj, Radanović Z, Čabilovski R, Manojlović M, Latković D (2017) Winter cover crops as green manure in a temperate region: the effect on nitrogen budget and yield of silage maize. *Crop and Pasture Science* **68**, 1060–1069.

Farooq M, Nadeem F, Gogoi N, Ullah A, Alghamdi SS, Nayyar H, Siddique KHM (2017) Heat stress in grain legumes during reproductive and grain-filling phases. *Crop and Pasture Science* **68**, 985–1005.

Gil J, Castro P, Millan T, Madrid E, Rubio J (2017) Development of new kabuli large-seeded chickpea materials with resistance to Ascochyta blight. *Crop and Pasture Science* **68**, 967–972.

Iglesias-García R, Prats E, Flores F, Amri M, Mikic A, Rubiales D (2017) Assessment of field pea (*Pisum sativum* L.) grain yield, aerial biomass and flowering date stability in Mediterranean environments. *Crop and Pasture Science* **68**, 915–923.

Maamouri A, Louarn G, Béguier V, Julier B (2017) Performance of lucerne genotypes for biomass production and nitrogen content differs in monoculture and in mixture with grasses and is partly predicted from traits recorded on isolated plants. *Crop and Pasture Science* **68**, 942–951.

Martos-Fuentes M, Fernández JA, Ochoa J, Carvalho M, Carnide V, Rosa E, Pereira G, Barcelos C, Bebeli PJ, Egea-Gilabert C (2017) Genotype by environment interactions in cowpea (*Vigna unguiculata* L. Walp.) grown in the Iberian Peninsula. *Crop and Pasture Science* **68**, 924–931.

Murube E, Campa A, Ferreira JJ (2017) Identification of new resistance sources to powdery mildew, and the genetic characterisation of resistance in three common bean genotypes. *Crop and Pasture Science* **68**, 1006–1012.

Oliveira RS, Carvalho P, Marques G, Ferreira L, Pereira S, Nunes M, Rocha I, Ma Y, Carvalho MF, Vosátka M, Freitas H (2017) Improved grain yield of cowpea (*Vigna unguiculata*) under water deficit after inoculation with *Bradyrhizobium elkanii* and *Rhizophagus irregularis*. *Crop and Pasture Science* **68**, 1052–1059.

Parihar AK, Basandrai AK, Saxena DR, Kushwaha KPS, Chandra S, Sharma K, Singha KD, Singh D, Lal HC, Gupta S (2017) Biplot evaluation of test environments and identification of lentil genotypes with durable resistance to fusarium wilt in India. *Crop and Pasture Science* **68**, 1024–1030.

Pazos-Navarro M, Castello M, Bennett RG, Nichols P, Croser J (2017) *In vitro*-assisted single-seed descent for breeding-cycle compression in subterranean clover (*Trifolium subterraneum* L.). *Crop and Pasture Science* **68**, 958–966.

Pecetti L, Annicchiarico P (2017) Assessing and overcoming genetic trade-offs in breeding grazing-tolerant lucerne. *Crop and Pasture Science* **68**, 952–957.

Pelzer E, Bourlet C, Carlsson G, Lopez-Bellido RJ, Jensen ES, Jeuffroy M-H (2017) Design, assessment and feasibility of legume-based cropping systems in three European regions. *Crop and Pasture Science* **68**, 902–914.

Poblaciones MJ, Rengel Z (2017) Combined foliar selenium and zinc biofortification in field pea (*Pisum sativum*): accumulation and bioavailability in raw and cooked grains. *Crop and Pasture Science* **68**, 265–271. doi:10.1071/CP17082

Qin X, Feng F, Li D, Herbert SJ, Liao Y, Siddique KHM (2017) Changes in yield and agronomic traits of soybean cultivars released in China in the last 60 years. *Crop and Pasture Science* **68**, 973–984.

Santos T, Marinho C, Freitas M, Santos H, Oppolzer D, Barros A, Carnide V, Igrejas G (2017) Unravelling the nutriproteomics from chickpea (*Cicer arietinum*) seeds. *Crop and Pasture Science* **68**, 1041–1051.

Serrano MC, Carbas B, Castanho A, Soares A, Vaz Patto MC, Brites C (2017) Nutrional quality traits characterization of a chickpea germplasm collection exploited in chickpea breeding in Europe. *Crop and Pasture Science* **68**, 1031–1040.

Sillero JC, Rojas-Molina MM, Emeran AA, Kharrat M, Winkler J, Khan HR, Flores F, Rubiales D (2017) Identification and multi-environment validation of resistance to rust (*Uromyces viciae-fabae*) in *Vicia faba*. *Crop and Pasture Science* **68**, 1013–1023.