BIBLIOGRAPHY

ODIAS, MANNYLEN P. APRIL 2013. Genotype x Environment Interaction of Five Entries of Garden Pea (*Pisum sativum* L.) Grown Organically in Three Different Locations of Benguet.

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ABSTRACT

The study was conducted at Tuludan, Atok, Topdac, Atok, and Balili, La Trinidad to determine the best location for organic production of garden pea based on yield and resistance to pest; determine the best garden pea genotypes adapted to organic production in three locations of Benguet based on yield and pest resistance; and determine the interaction of garden pea entries with the environments represented by the three locations of Benguet using the AMMI (Additive Main Effects Multiplicative Interaction) analysis model. The field experiment was conducted from the month of September 2012 to January 2013.

Tuludan, Atok (2315 masl) was favorable for organic production of garden pea. Entry Chinese had the highest number of flowers per plant, flower cluster per plant and pods per plant that resulted to high pod yield. It also had high resistance to semi-looper, mild resistance to pod borer and low incidence of *Fusarium* wilt.

Based on AMMI analysis, the best location for organic production of garden pea was Tuludan, Atok (2315 masl) since plants produced high pod yield. Entry Chinese is adapted at Tuludan, while CGP 13 is adapted at La Trinidad (1332 masl). Entries CGP 59, CGP 34, and Betag may also be grown organically at Topdac, Atok (1459 masl).

INTRODUCTION

Garden pea locally known as *citzaro,* is an annual legume grown for its edible pods and matured seeds. In Benguet where the weather is generally cool throughout the year, garden peas are not difficult to grow as this crop generally favors a relatively cool climate (PCARRD, 1982).

Garden pea production is generally costly and subject to various pest such as leafminer, fusarium wilt and powdery mildew (PCARRD, 2003). Organic production of garden pea where chemical pesticides are not used may be an alternative to reduce cost of production. However, organic garden pea is produced in limited quantities due to lack of suitable varieties. Thus, the need for evaluation of possible varieties of garden pea for organic production arises. Initial researches on evaluation of garden pea lines for organic production were done however the challenge to continuously select varieties for organic production in different locations remains (Tabangcura, 2012).

Garden pea varieties suitable for organic production have to be adapted to local farmer's fields and must be responsive to low inputs. This objective will be achieved with systematic evaluation of garden pea lines in a multi-location trial to be able to select the best adapted varieties to specific locations and to allow observation of varietal performance across a wide range of test sites within the region. However, studies on suitability of organic garden pea varieties to specific locations without the use of an appropriate tool to analyze G x E interactions may result in unreliable selections and recommendations. A very useful tool to identify suitable varieties is the Additive Main Effects Multiplicative Interaction (AMMI) that offers a tremendously cost- effective option for increasing accuracy.

AMMI's different estimates often lead to different rankings of the genotypes (varieties) within each environment (location), and hence to different selections of the best material (variety). The greater AMMI accuracy implies better selections, even with less field data. The most accessible program to analyze G x E interactions is CropStat 7.2.2 version (Tad-awan *et al.*, 2007).

Thus, the study was conducted to:

1. determine the best location for organic production of garden pea based on yield and resistance to pest;

2. determine the best garden pea entries adapted to organic production in three locations of Benguet based on yield and pest resistance; and

3. determine the interaction of garden pea entries with the environments represented by the three locations of Benguet using the AMMI (Additive Main Effects Multiplicative Interaction) analysis model.

This study was conducted at La Trinidad and Atok (Tuludan and Topdac), Benguet from September 2012 to January 2013.

REVIEW OF LITERATURE

Description of Garden pea

Garden pea locally known as a 'chinese pea', 'snow pea', 'sweet pea' or 'sitsaro', is the most expensive vegetable legumes in the country. It is grown for its edible pods or seeds. It grows well in Benguet, where the climate is cool throughout the year. Garden pea seeds contain considerable amounts of digestable protein, carbohydrates, and minerals, while the green pods are rich sources of vitamin A. garden peas is a popular ingredient in 'chop suey' and 'pancit'. It also makes an important addition in soups, sautés, and any dish with mushrooms, bamboo shoots, and shrimps. Recognizing its importance to the industry, PCARRD-DOST identified sweet pea, among others, as a priority crop under the National Vegetable R&D Program (PCARRD-DOST, 2003). The crop is also suitable as forage, hay, silage, and green manure. Kenya export of garden peas in 2005 amounted to 2,206 tons at a value of KSh 729 million, and snow peas 1,739 tons at a value of KSh 448 million. Total area of garden peas in 2005 was 5,313 hectares and for snow peas 1,550 hectares for both local and export market (GIAA, undated).

The pea is cool season crop and thrives best when the weather is cool and when ample moisture is available. The young plants will tolerate considerable cold and light frosts, but the flower and green pods are often injured by heavy frost. If the crop is planted late, maturity takes place when the temperatures are too high for optimum growth and yields. Therefore, it is important to plant late enough to avoid freezes, yet early enough to mature the crop before hot weather. Pea plants are very sensitive to drought and grow best in regions of moderated rainfall with irrigation (McCollum and Ware, 1980).

Organic Production

Organic agriculture is a holistic production management system which promotes and enhances health, including biodiversity, biological cycles, and soil biological activity. It emphasizes the use of management practices in preference to the use of off-farm inputs, taking into the account that regional conditions require locally adapted systems, biological, and mechanical methods, as opposed to using synthetic materials, to fulfill any specific function within the system (Kristiansen and Reganold, 2006).

In the Philippine setting, the organic movement started as early as the 1980s from a series of initiative from non-government organizations. Today the government recognizes organic agriculture as the address to the problems in agricultural production and increasing farmers' earnings. Locally, organic agriculture has always been existent in the Cordilleras. It is often referred as the indigenous farming practices much focused on production for food sufficiency. The adoption of the mother technology or conventional farming system or the use of chemical inputs came about in the Cordilleras when farmers started to commercialize their production to earn more income. The province of Benguet, credited as the salad bowl of the Philippines, is the main supplier of the country's upland vegetable requirements supplying almost 90% of the country's total consumption. These characteristics make the province a potential and suitable for organic agriculture. When the Benguet Vegetable industry suffered a severe crisis with the cyanide scare and trade liberalization of vegetables, niche market production, good production systems and chemical-free farming were seen as the possible response to bring back the good image of the local vegetable industry. Several initiatives were already carried out by the Local Government Units to promote the shift to organic farming such as organizing farmer groups to demonstrate the potentials organic farming. Among these groups include La TOP or La Trinidad Organic Practitioners organized by the La Trinidad Municipal Agriculture Office to demonstrate organic agriculture, marketing, personal development and organic eco-tourism in La Trinidad (Ongpin Foundation, 2010).

Genotype x Environment Interaction

With regard to the comparison of plant material in a set of multi-environment yield trials, the term genotype refers to a cultivar (i.e. with material genetically homogeneous, such as pure lines or clones, or heterogeneous, such as open-pollinated populations) rather than to an individual's genetic make-up. The term environment relates to the set of climatic, soil, biotic (pests and diseases) and management conditions in an individual trial carried out at a given location in one year (in the case of annual crops) or over several years (in the case of perennials). In particular, an environment identifies a given location-year (annuals) or location-crop cycle (perennials) combination in the analysis of trials repeated over time (FAO, 2002). G x E interaction means that difference of environment does not have the same effects on a genotype. A specific difference environment may have greater effects on some genotype than others than others. In other words, genotype A might be superior to Genotype B in Environment X, but inferior in environment Y (Qian, 1997).

Purely environmental effects, reflecting the different ecological potential of sites and management conditions, are not of direct concern for the breeding or recommendation of plant varieties. Genotypic main effects (i.e. differences in mean yield between genotypes) provide the only relevant information when genotype × environment (GE) interaction effects are absent or ignored. However, differences between genotypes may vary widely among environments in the presence of GE interaction effects as large as those reported in extensive investigations). In general, GE interactions are considered a hindrance to crop improvement in a target region. Moreover, such effects may contribute, together with purely environmental effects, to the temporal and spatial instability of crop yields. Temporal instability, in particular, has a negative effect on farmers' income and, in the case of staple crops, contributes to food insecurity at national and household level. On the other hand, GE interactions may offer opportunities, especially in the selection and adoption of genotypes showing positive interaction with the location and its prevailing environmental conditions (exploitation of specific adaptation) or of genotypes with low frequency of poor yield or crop failure (exploitation of yield stability) (FAO, 2002).

The study, "Vulnerability and Adaptation Capacity Assessment" in Benguet showed that there are changes in the climate that directly and indirectly affects agriculture and biodiversity (Kiaso, 2012). Benguet with its very diverse climatic conditions and soil types escalates the problem of GEI even further. To overcome this problem, the universal practice of scientists in most crops when selecting genotypes, is to plant (Martin, 2004) new cultivars, which are being tested, at several locations and over several years (IRRI, 2006) in yield (performance) trials to ensure that the selected genotypes have a high and stable performance over a wide range of environments. The assessment of genotype performance in genotype x location x year experiments is often difficult but is essential for the successful selection of stable and high yielding varieties (Aremu *et al.,* 2007).

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

The study was conducted At Tuludan and Topdac, Atok, and Balili La Trinidad to determine best location for organic production of garden pea based on yield and resistance to pest; determine the best garden pea entries for organic production in three locations of Benguet based on yield and pest resistance; and determine the interaction of garden pea entries with the environments represented by the three locations of Benguet using the AMMI (Additive Main Effects Multiplicative Interaction) analysis model. The field experiment was conducted from the month of September 2012 to January 2013.

In terms of location, plants in Tuludan had 100% survival at 35 DAE, highest number of flowers per plant, flower cluster per plant and number of pods per plant. Plants in Tuludan were also highly resistant to semi-looper at 50 and 60 DAE, as well as pod borer at 60 and 72 DAE; had the least percentage of plants infected with *Fusarium* wilt at 60 DAE and late occurrence of powdery mildew (95 DAE). Entries grown in Tuludan had the highest marketable and total pod yield and least weight of non-marketable pods.

In terms of garden pea entries, plant height at 35 DAE of entries Betag, CGP 59, CGP 34 and CGP 13 were comparable while at 75 DAE entry Chinese was the tallest. Entry Chinese had the highest number of flowers per plant, flower cluster per plant, and pods per plant. Entry Betag had a comparable pod length with CGP 34. The entries were highly resistant to semi-looper at 50 DAE. However at 60 DAE, only Chinese remained highly resistant. The entries were mildly resistant to pod borer infestation at 72 DAE. Entry Chinese had the highest pod yield.

Based on AMMI analysis, environment caused the most variation in G x E interaction. Tuludan imparted the highest marketable and total pod yield. Chinese and CGP 13 had high pod yield. Chinese positively interacted with Tuludan, CGP 13 with La Trinidad, and CGP 59, CGP 34 and Betag with Topdac.

Conclusions

Based on combined analysis, Tuludan is well suited for organic production of any of the five garden pea entries evaluated for high pod yield and decreased pest and disease infection. All the entries had no significant differences in terms of yield and thus may all be considered for organic production.

Furthermore, Chinese organically grown in Tuludan is best for high yield and resistance to pest.

Based on AMMI analysis, the environment caused the highest variation in G x E interaction. Entry Chinese had high yield and is adapted in Tuludan. CGP 13, on the other hand, had high yield and is specifically adapted in La Trinidad. Entries CGP 59, CGP 34 and Betag are adapted in Topdac.

Recommendations

Based on combined analysis, Tuludan, Atok is recommended for growing garden pea organically due to high pod yield, low infestation of semi-looper and pod borer, and late occurrence of powdery mildew. Entry Chinese and CGP 13 are recommended to be grown organically due to high pod yield and resistance to pest.

Based on AMMI analysis, entry Chinese is recommended at Tuludan, Atok while CGP 13 is recommended in La Trinidad. Entries CGP 59, CGP 34 and Betag may also be grown in Topdac, Atok.

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