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Effect of sowing techniques and seed pesticide application on dry bean yield and harvest components

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Abstract

Common bean, *Phaseolus vulgaris* L., is widely cropped by small farmers in the northwest of Spain. The emergence and establishment of common beans are affected by insects, soil fungi and crust formation. The objective of this study was to determine if seed pesticide application and sowing techniques improve bean yield. This work was carried out during 1998 and 1999 in the province of León, Spain. A split-split-plot design with three replications was used. The main plot was bean cultivar (''Riñón de León'' and ''Canela''), the subplot was the application system of pesticides (untreated, treatment on seed before sowing and treatment on seed during sowing) and the sub-subplot was the sowing technique (sowing in raised beds, sowing on the flat without adding substrate, sowing on the flat adding sawdust and sowing on the flat adding vermiculite). The plant population density at harvest and yield was improved by pesticide application and by addition of substrate in the seed row. Yield increase was caused by a higher plant population density at harvest. The sowing techniques had a greater influence on plant population density at harvest and bean yield than the pesticide treatment carried out for its protection. Seed pesticide application improved number of pods per plant and 1000-seed weight.

Keywords: Bean seed fly; *Phaseolus vulgaris*; Raised bed; Root rot; Seed treatment; Soil crust; Sowing techniques

1. Introduction

Common bean (*Phaseolus vulgaris* L.) is potentially the most valuable source of plant protein in the northwest of Spain, and contributes significantly to the sustainibility of traditional cropping systems, because of the predominance of small-scale bean farmers. The socio-economic peculiarities of Province of León (main common bean-producing area in Spain) have made possible the maintenance of traditional varieties. Bush bean genotypes, with growth habit type I (Singh, 1982), are growing in popularity due to ease of mechanisation and management of the crop and their general suitability for cultivation as a sole crop.

Seed treatment and sowing technique are fundamental operations because initial stages in plant development are the most susceptible to adverse environmental conditions (Martins and de Carvalho, 1993). Seed pesticide application and sowing techniques improve the emergence and establishment of the crop (Valenciano et al., 2004b). The main problems that affect establishment, and whose incidence can vary according to the seed treatment and sowing technique used, are: bean seed fly attack, fungal diseases (especially root rots) and existence of superficial crust that represents a physical barrier to the emergence of plants.

The bean seed fly (*Delia platura* [Meigen]) affects the buried seed or the cotyledons of the seedling before sprouting. The larvae penetrate the germinating seeds or seedlings and mine the cotyledons, small shoots and/or young roots before sprouting. The longer the lapse between sowing and emergence of the cotyledons, the greater is the

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risk, attacks also being favoured by high moisture and low temperatures conditions (Montecnios et al., 1986), and by a high content of organic matter in the soil. Since the attack affects buried seed or cotyledons, the seeds are treated before sowing with insecticides (Trotus and Ghizdavu, 1996). Applying insecticides to the soil also gives good results, but, when the fly populations are large, then a combination of seed and soil treatment becomes necessary (Montecnios et al., 1986).

Root rots are the main diseases caused by soil fungi and occur in all regions where common bean is cultivated (Beebe and Pastor-Corrales, 1991). They cause loss of plants, limit seriously establishment and can lead to reduced plant development (Tu, 1992). These fungi can affect common bean individually or associated; antagonism and synergism phenomena may then be observed (Davet et al., 1980). They are always crucially involved in low productivity in some fields. These diseases may be divided in three groups, based on the plant organ or growth stage they affect: damping-off, root rot and wilts. Damping-off causes seed rot, in pre-germination or in germination stages, or plant death after germination. Root rot causes rot and/or destruction of the root restricting the absorption of water and nutrients. Wilts appear after flowering, so they do not influence the establishment of common bean plants. Rapid emergence can reduce root rot (Phillips, 1989), thus the use of different sowing techniques can be related directly with root rot presence especially those that support a favorable microclimate for their development (Barrera, 1997). The use of fungicides increases germination and plant growth, reduces damping-off, and improves emergence (Gupta et al., 1999). The application of seed pesticides results in improved plant emergence because it reduces plant mortality associated with damping-off and root rot (Tu and Zheng, 1993), thus improving the yield.

The superficial soil crust is a physical barrier to plant emergence (Awadhwal and Thierstein, 1985; Debicki, 1994; Tarchitzky et al., 1984) and for crop establishment. It is one of the greatest problems limiting productivity in many parts of the world (Torres-Guy and Hakansson, 1995). The formation of a crust is dependent on soil characteristics, soil management conditions and the environment (Bresson, 1995; Chartres and Greeves, 1998). Crust formation before plant emergence leads to reduced establishment because it prevents emergence (Debicki, 1994). When formation occurs during emergence, it causes broken plants. It may also cause strangulation problems if the formation occurs after emergence (Awadhwal and Thierstein, 1985). Organic material scattered over the soil surface reduces crust formation (Chartres and Greeves, 1998; Henning and Wiebe, 1994). The addition of substrates over the seed zone protected the surface of the soil (Henning and Wiebe, 1994) preventing superficial crust formation, and may improve emergence and yield.

This study evaluates the effect of sowing technique and seed pesticides on the plant population density at harvest and on yield and yield components.

2. Material and methods

2.1. Site characteristics

Four experimental environments were established in the province of León (Spain), two in 1998 and two in 1999, using two traditional bean genotypes (''Canela'' and ''Riñón de León'') and different sowing methods. The site characteristics are shown in Table 1.

The 1998 plots were located in Ribas de la Valduerna and San Pedro Bercianos and had an organic matter content of 2.8 and 2.2%, and a loam and sandy loam texture, respectively. Sugar beet was the previous crop in both plots. The 1999 plots were located in Ribas de la Valduerna and Bercianos del Páramo, and had an organic matter content of 2.5 and 1.1%, respectively, and a loamy texture. The previous crop at Ribas de la Valduerna had been wheat and maize at Bercianos del Páramo.

2.2. Experimental design

Sowing was carried out following a statistical pattern of subdivided plots (split-split-plots) with three replicates, randomized complete blocks and three factors.

The main factor was bean genotypes, ''Riñón de León'' and ''Canela'', whose characteristics appear in Table 2.

The secondary factor was pesticides treatment: Himexazol and Diazinon in combination. Doses were those recommended by the manufacturers (0.001 m^3/m^3 for Himexazol and 0.002 m^3/m^3 for Diazinon), with three different application methods: (1) zero application (untreated seeds), (2) treatment of seeds before sowing and (3) treatment in the seed row directly on the soil during sowing (i.e. after placing the seed on the soil but before burying it).

Table 1
Climatic conditions and site characteristics of locality where the experimental plots were established during the experimental period

	Locality			
	Ribas de la Valduerna[a]		San Pedro Bercianos[b] (1998)	Bercianos del Páramo[b] (1999)
	1998	1999		
Average rainfall (mm)				
May	70.3	48.9	78.1	105.9
June	49.0	22.5	52.2	24.5
July	5.7	33.2	0.0	36.3
August	14.1	26.9	7.2	43.5
Average temperature (°C)				
May	9.4	10.4	13.0	13.4
June	14.3	12.8	17.2	17.1
July	18.3	20.2	19.4	20.6
August	20.1	18.9	20.7	19.4
Longitude	5°57.1′W		5°42.2′W	5°42.2′W
Latitude	42°18.5′N		42°23.6′N	42°22.8′N
Altitude (m)	799		828	824

[a] Source: Meteorological Station of Astorga, Spain.
[b] Source: Meteorological Station of Laguna Dalga, Spain.