

Production and resistance of three scallion cultivars to pink root

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ABSTRACT

The production of scallion has been widely exploited on small farms, since it requires little care and is largely commercialized close to the production sites. Pink root, caused by *Phoma terrestris* (syn. *Pyrenochaeta terrestris*), is among the main diseases affecting this crop. However, little information on aspects related to yield and few cultivars resistant to the disease are available. In this study we evaluated these variables on Konatsu, Natsu and Nebuka cultivars. The experiment was carried out in Lontras, Santa Catarina state, Brazil, in a complete randomized blocks design with four replications. After 80 days of transplantation the following parameters were evaluated: plant mass, total and marketable number of leaves, total and marketable mass of leaves, length and weight of roots. The total number of bunches was assessed as an evaluation aiming the market. The disease severity, in percentage on the root system, was assessed for the pink root. The average values of the variables were subjected to analysis of variance by F test and mean comparison test by Tukey, 5%. The Konatsu cultivar presented higher average mass per plant (159 g plant⁻¹) compared to Nebuka and Natsu cultivars. The average mass of marketable leaves for 'Konatsu' was 56.17% higher than for 'Nebuka'. The number of bunches produced by 'Konatsu' was 48% higher than for 'Nebuka'. The cultivar Konatsu was, therefore, more productive and resistant to the pink root disease.

Keywords: *Allium fistulosum*, *Phoma terrestris*, yield, genotypes.

RESUMO

Produção e resistência à raiz rosada em três cultivares de cebolinha-verde

A produção de cebolinha-verde tem sido muito explorada em pequenas propriedades, já que exige poucos cuidados e grande parte é comercializada próxima aos locais de produção. Entre as principais doenças da cultura, está a raiz rosada causada por *Phoma terrestris* (sin. *Pyrenochaeta terrestris*). No entanto, poucas são as informações sobre características de produção e resistência de cultivares a essa doença. O objetivo deste trabalho foi avaliar essas variáveis nas cultivares Konatsu, Natsu e Nebuka. O experimento foi instalado em Lontras-SC, em delineamento experimental de blocos casualizados com quatro repetições. Após 80 dias do transplantio foram avaliados a biomassa das plantas, o número total e comercial de folhas, a biomassa de folhas totais e comerciais, o comprimento de folhas, e o comprimento e biomassa de raízes. Para a análise comercial foi determinado o número total de maços. Para a raiz rosada foi avaliado o percentual de severidade da doença no sistema radicular. As médias das variáveis foram submetidas à análise de variância pelo teste F e a comparação de médias foi realizada pelo teste de Tukey a 5% de probabilidade. A cultivar Konatsu apresentou maior biomassa da planta (159 g planta⁻¹) em relação à Natsu (89,5 g planta⁻¹) e Nebuka (72,75 g planta⁻¹). A biomassa de folhas comerciais da cultivar Konatsu foi 56,17% maior que da cultivar Nebuka. O número de maços produzidos por Konatsu foi 48% maior ao da cv. Nebuka. A cultivar Konatsu foi mais produtiva e resistente à doença.

Palavras-chave: *Allium fistulosum*, *Phoma terrestris*, produtividade, genótipos.

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The production of condiments is an important source of income and sustainability for small farms. The scallion, also known as spring onion, is one of the condiments which is in high demand by consumers, either in raw, *in natura*, or processed. Due to high industry demand, its cultivation is being done on a larger scale. The fresh fruit market is done in fairs and supermarkets (Ferreira *et al.*, 1993). According to Ferreira & Casimiro (2011), the scallion is an important crop that contributes to the life quality of farmers, since its high added value and the family labor

involvement provides a condition for sustainability on the farm.

The scallion (*Allium fistulosum*) is the predominant species for cultivation in Brazil and it adapts to various types of soil and to a wide range of temperatures, mild or cold. It can be grown throughout the year in highlands regions and during autumn-winter in lower regions. It is a perennial plant which presents cylindrical and fistulous leaves, 0.30 to 0.50 m height, produces small and tapered bulbs, wrapped in a pink film, with tillering and clump formation (Filgueira, 2007).

In Brazil, the most used cultivar is "Todo Ano", which presents as a characteristic the light green color. However, Japanese cultivars, like "Nebuka", "Evergreen", "Natsu Hosonegui" which are intense green, are also used (Cotia, 1987; Makishima, 1993; Filgueira, 2007). In Santa Catarina, in spring/summer crops, it has been recommended to grow the cultivar Futonegui and in autumn/winter the cultivars "Todo o Ano", Nebuka, Hosonegui and Ibirité (Silva & Della Bruna, 2009).

The production of the scallion "Todo

Ano” was evaluated by Heredia *et al.* (2003), and they concluded that the production of fresh biomass without the roots was of 7.95 t ha⁻¹ and the average height was 33.21 cm per plant. Heredia & Vieira (2004) verified the production of 28,773.6 bunches ha⁻¹ in cultivar “Todo Ano.”

The scallion crop has shown a frequent disease in its root system, called the pink root, caused by *Phoma terrestris* (*sin. Pyrenochaeta terrestris*). This disease is widespread in countries where alliaceous are grown and resulting damages intensified by the fact that they fit the permanent cultivation succeeding annual cycles in the same area. In Brazil, the first occurrence of pink root was reported by Chaves & Erickson, in 1960, on onion crops in the state of Minas Gerais (Wordell Filho & Boff, 2006). Although *Phoma terrestris* is a low specific pathogen found in soil where alliaceous are grown, its occurrence intensifies in hot regions, where the continuous cultivation of this crop and the conventional management are adopted (Lenz, 2005).

The increase in consumer demand for scallion has stimulated the search for new varieties that respond to highest yields. However, the growing in Santa Catarina weather conditions can present distinct production and commercial characteristics, resistance reaction to pink root not corresponding to what was reported in the environment where the cultivars were generated. Due to this fact, this work aimed to evaluate the behavior of three scallion cultivars in relation to the aspects of productivity, commercial and resistance to pink root.

MATERIAL AND METHODS

The experiment was carried out from November 10, 2011 to January 30, 2012, on a farm, with natural history of scallion disease, located in Lontras, Santa Catarina state (27°10'S, 49°30'W, altitude 360 meters). The local climate is Cfa type, according to Köppen classification. The experiment was carried out on a soil classified as Cambisol Dystrophic medium texture (Embrapa, 2006). The soil analysis of

the experimental field was carried out by the Soil Laboratory of Epagri in Ituporanga; the samples collected at the depth of 20 cm, presented: clay = 38%; pH (H₂O) = 4.6; pH (SMP) = 5.4; organic matter = 2.4%; P (Mehlich1) = 38.7 mg dm⁻³; H + Al = 8.7 cmolc dm⁻³; K = 316 mg dm⁻³; CTC (pH 7.0) = 13.5 cmolc dm⁻³; Al = 2.6 cmolc dm⁻³; Ca = 2.7 cmolc dm⁻³; Mg = 1.3 cmolc dm⁻³.

The seedlings of cultivars Konatsu, Natsu and Nebuka were grown in trays with 128 cells, filled with soil substrate Carolina® constituted by Canadian peat, vermiculite, rice husk. The seeding rate was on average 12 seeds per cell.

The soil correction was adjusted to pH 6.0 with dolomitic limestone, three months before the implementation of the experiment. The basic fertilization was carried out according to Filgueira (2007) recommendation; 30 kg ha⁻¹ N; 300 kg ha⁻¹ P and 120 kg ha⁻¹ K of formulation 5-20-10. At 28 days after sowing, the seedling transplantation was done. The spacing used was of 15x25 cm, in seedbeds previously prepared, measuring 10 cm high, 1.0 m wide and 1.5 m long. The top dressing with 33.3 kg ha⁻¹ N, using urea, was performed at 20, 40 and 60 days after the hand weeding of the experiment field. No pests and foliar diseases were observed during the conduction of the experiment and no pesticide was applied.

The treatments consisted of the cultivars Konatsu, Natsu and Nebuka arranged in a randomized block design with four replications. The replications contained 50 plants arranged in five rows of 10 plants.

The harvest was carried out 80 days after the transplantation, when the plants were in an upper stage, higher than 35 cm (Filgueira, 2007). Ten plants, at random, in each replication were collected and evaluated for the following variables: mean biomass per plant, mean biomass of leaves, average number of leaves, mean length of leaves, mean biomass of marketable leaves, average number of marketable leaves, average number of marketable bunches, mean fresh biomass of roots and average length of root. In the evaluation of marketable productivity, the total number of bunches with 100 g

of mass was determined.

To evaluate the intensity of pink root, a scale, according to Maranhão *et al.* (2013) was used, in which the level of the disease symptoms ranges from 0 to 5 (0 = roots without symptoms; 1 = with light pink symptoms; 2 = with pink symptoms; 3 = with dark pink symptoms; 4 = necrotic roots; 5 = dead roots). After the evaluation using the scale, the level of the symptom was converted to the percentage of severity by Townsend & Heuberg's (1943) formula described by disease severity (%) = $\Sigma (n.v) / N.V \times 100$, where: n = degree of infection according to the scale; v = number of roots evaluated per plant; N = total number of roots evaluated and V = highest degree infection (5), attributed in the scale proposed by Maranhão *et al.* (2013).

During the experiment, the monthly rainfall (mm) measured, using a rain gauge installed in the experiment, was of 66 mm in November, 104 mm in December and 218 mm in January.

The data for each variable were subjected to analysis of variance (ANOVA) F-test for the comparison of means by Tukey test at 5% using the software SASM-Agri (Canteri *et al.*, 2001).

RESULTS AND DISCUSSION

The cultivar Konatsu showed the highest fresh biomass per plant, higher than 56.11% and 45.66% compared to the cultivars Natsu and Nebuka, respectively. Natsu did not differ statistically from Nebuka related to fresh biomass per plant (Table 1). Highest mean fresh biomass of leaves (132.25 g plant⁻¹) was found also for Konatsu, compared to Natsu (59.75 g plant⁻¹) and Nebuka (58.25 g plant⁻¹) according to presented in Table 1. The appropriate growth and development of the plants depend on the combination of crop management, environmental factors and genetic potential of the cultivar (Puiatti & Finger, 2005). As in this work the growing and environmental conditions were similar, the results obtained were directly linked to the genotype, since these conditions are not influenced by

Table 1. Production of fresh biomass of the entire plant and aerial part of scallion cultivars (produção em biomassa fresca da planta inteira e da parte aérea de cultivares de cebolinha-verde). Lontras, IFC, 2011.

Cultivar	Biomass (g/plant)	Foliar biomass (g/plant)	Leaves (n°/plant)	Leaf length (cm)
Konatsu	159.50 a	132.25 a	35.77 a	46.35 a
Natsu	89.50 b	59.75 b	33.67 a	45.57 ab
Nebuka	72.75 b	58.25 b	18.60 b	41.76 b
CV (%)	18.23	27.11	14.47	4.72

Means followed by the same letter, in the same column, did not differ significantly from each other, Tukey, $p < 0,05$ (médias seguidas pela mesma letra, na coluna, não diferem significativamente entre si, Tukey, 5%).

Table 2. Commercial production in different cultivars of scallion (produção comercial em diferentes cultivares de cebolinha-verde). Lontras, IFC, 2011.

Cultivar	Marketable leaves (g/plant)	Marketable leaves (n°/plant)	Marketable bunches (n°)
Konatsu	103.25 a	26.20 a	11.00 a
Natsu	47.25 b	23.87 a	6.25 b
Nebuka	45.25 b	13.51 b	5.75 b
CV (%)	26.95	13.12	22.28

Means followed by the same letter, in the same column, did not differ significantly from each other, Tukey, $p < 0,05$ (médias seguidas pela mesma letra, na coluna, não diferem significativamente entre si, Tukey, 5%).

Table 3. Severity of pink-root and fresh biomass of roots of scallion cultivars (severidade de raiz rosada e biomassa fresca de raiz de cultivares de cebolinha-verde). Lontras, IFC, 2011.

Cultivar	Pink root (%)*	Fresh biomass of roots (g/plant)	Length of roots (cm)
Konatsu	70.26 b	28.25 a	12.12 ^{ns}
Natsu	78.78 a	22.00 a	12.00
Nebuka	80.54 a	13.75 b	12.98
CV (%)	2.26	14.17	9,56

Means followed by the same letter, in the same column, did not differ significantly from each other, Tukey, $p < 0,05$ (médias seguidas pela mesma letra, na coluna, não diferem significativamente entre si, Tukey, 5%). *Severity expressed by calculating Heuberg & Townsend (1943) described by Severity (%) = $\sum (n.v) / N.V \times 100$, where: n= note in the scale; v= number of roots per plant evaluated; N= total number of roots evaluated and V= value of the highest score (5) [severidade expressa pelo cálculo de Townsend & Heuberg (1943) descrita por Severidade (%) = $\sum (n.v) / N.V \times 100$, onde: n= nota da escala; v= n° de raízes avaliadas por planta; N= n° total de raízes avaliadas e V= valor da maior nota (5)].

genotype x environment interaction (Squilassi, 2003; Borém, 2013).

The number of leaves in the cultivars Konatsu and Natsu were statistically similar, considering that Konatsu was 52% superior to Nebuka. The same difference was found in the total length of leaf, in which cultivar Nebuka was lower in 9.9% compared to Konatsu, which directly reflects the number of bunches produced. Natsu did not differ statistically from Konatsu (Table 1). The

leaf length of Konatsu (46.35 cm) did not differ statistically from Natsu (45.57 cm), being higher than 31.21 cm found by Heredia *et al.* (2003).

In relation to commercial variables, the marketable leaf biomass of the cultivar Konatsu showed a difference of 54.23% when compared to Natsu and 56.17% to Nebuka (Table 2). The disposal in cultivar Nebuka was higher, due to the reduction of the leaf biomass (Table 1) and the gain of

marketable leaf biomass (Table 2) in 22.32%, followed by Konatsu (21.92%) and 20.92% for Natsu. In relation to marketable bunches, the cultivar Konatsu produced 11 bunches, being higher than 43%, compared to Natsu and 48% for cultivar Nebuka (Table 2). No statistical difference in the number of bunches was observed between the cultivars Natsu and Nebuka. Heredia *et al.* (2003) and Heredia & Vieira (2004) also used the production of bunches as a variable in the evaluation of the productivity of scallion. No significant differences were noticed by F test among the cultivars for fresh biomass of the roots and root length (Table 3).

The cultivar Konatsu differed statistically from the other cultivars, presenting lower disease intensity (70.26%). When comparing Konatsu to the other cultivars, it presents 10.81% and 12.8% less severity than Natsu and Nebuka, respectively. The percentage of severity between Natsu and Nebuka did not differ statistically (Table 3). As the fungus focuses on all stages of plant development, the most characteristic symptom is the pink color, and the evolution of the colors is accompanied by wrinkling of the tissues to the death of the root (Wordell Filho & Boff, 2006). This process stops the development of the plant. After the death of the root, the plant suffers a reduction in water supply and nutrients which causes a lower vegetative development, which is presupposed to be negatively influencing the total and commercial yield (Tables 1 and 2). This was also verified by Maranhão *et al.* (2013), who observed reduction of 60% in the root system in onion by different strains of the pathogen. Despite the high level of severity in the roots, the pathogen is considered weak, since the pink color is due to the diffusion of mycelial pigment in the tissue of infected root and the scaling used may overestimate the severity of the disease. In Brazil, the pathogen is found in all the regions where onion is grown, however direct losses caused by the disease have not been reported yet (Wordell Filho & Boff, 2006). However, in this study, some evidences that the factor responsible for lower productivity, in scallion, is due to

the pathogen under study are noticed, since this pathogen directly influenced the production differences among the cultivars evaluated.

According to the results, the cultivar Konatsu showed the highest resistance in the area with the presence of the pathogen providing greater commercial productivity among cultivars of scallion.

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