Asian Journal of Plant Sciences

ISSN 1682-3974

science alert

ANSInet
an open access publisher
http://ansinet.com

Asian Journal of Plant Sciences
Volume 1 Number 2: 197-198, 2002

Optimizing Plant Density Cum Weed Control Method For Puccinial Rust Management and Yield in Garlic

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Abstract: Seven different plant densities (0.44, 0.53, 0.67, 0.8, 1.0, 1.3 and 2.0 million plants ha^{-1}) and two weed control methods (manual and chemical), compared with no weeding as control, were evaluated in different combinations to find the best interaction for effective rust control and high production in garlic. The lowest value (65.33) of area under disease progress curve (AUDPC) was recorded in treatment where plant population @ 1 million ha^{-1} and hand weeding were used. Yield (14 t ha^{-1}) and bulb index (4.6 cm) in this treatment were statistically at par with their respective highest values indicating that its performance was better than other treatments in rust control and garlic yield.

Key words: Garlic, *Allium sativum*, garlic rust, *Puccinia porri*, plant density, weed control, disease management

Introduction

Garlic (*Allium sativum* L.) occupied 2.9 thousands ha in the North West Frontier Province (NWFP) of Pakistan with a total production of 30.9 thousand tons during 1998-99 (Anonymous, 2000). The severe attack of Puccinial rust (*Puccinia porri*. Wint) on the crop during favorable disease development years reduces its yield substantially. Spray fungicides are rarely applied to the crop, while the use of other management practices is almost negligible. It is why important that some easy- to- adapt control measures shall be investigated to combat the disease. Mohibullah (1991) reported that by decreasing plant population from 2 to 0.5 million ha^{-1}, 10% decrease in rust severity and 28% increase in garlic yield were obtained. In a different experiment, 75% decrease in plant population caused 20% reduction in downy mildew severity and 23% increase in onion yield. Weed control had also played an important role in management of garlic rust. Sherf and Macnab (1986) recommended destruction of related weeds for control of the disease. Schwartz and Mohan (1995) opined that control of weeds belonging to the onion family help reduce incidence of garlic rust. Ahmad and Khan (1999) reported that herbicide Roanstar in combination with manual weeding reduced downy mildew attack and increased onion yield by more than two-folds compared to untreated control.

Keeping in view the importance of both practices, this investigation was initiated to find their best combination that may guarantee the effective control of rust and high yields in garlic.

Materials and Methods

An experiment consisting of seven plant densities (0.44, 0.53, 0.67, 0.8, 1.0, 1.3 and 2.0 million plants ha^{-1}) of cv. Local and two weed control methods i.e., manual and chemical with herbicide Roanstar(@ 10 ml L^{-1}), compared with no weeding as control, was laid out under artificial epiphytotic field conditions in a split-plot fashion with plant densities in the main and weed control methods in subplots. Each treatment was replicated thrice. Disease severity was scored at weekly intervals on a scale reported by Mohibullah (1991) and converted to AUDPC following Shanner and Finney (1977). Data on yield and bulb index were recorded at the time of harvest of the crop. Analysis of variance of the data was performed using MSTAT-C Statistical Software Package (Michigan State University, USA) and treatment means were differentiated through Duncan's Multiple Range Test (Duncan, 1955).

Results and Discussion

The interactive effects of plant densities and weed control methods on rust and different yield parameters were the following:

Area under disease progress curve: Significant differences (P=0.05) occurred in AUDPC values of different treatments. The lowest value was recorded in treatment with one million plants ha^{-1} plus hand weeding and the highest in treatment having two million plants ha^{-1} and no weeding (Table 1). The former showed 66.6% decrease than the latter. The second lowest value was in treatment where herbicide Roanstar was sprayed on plants maintained at one million ha^{-1}. Difference between this and treatment with the lowest AUDPC value was nonsignificant indicating that this plant density with either weed control method performed significantly than other treatments. Probably plant populations higher than this provided conducive microenvironment for disease development while those lower than this encouraged vigorous and dense growth of weeds that helped in survival and dissemination of fungus inoculum.

Table 1: Combined effect of plant density and weed control method on rust severity and yield in garlic

Treatment	AUDPC	Yield (t ha^{-1})	Bulb index (cm)
Two million plants ha^{-1}			
Hand weeding	109.7h-k	14.4a	4.0c
Roanstar @ 10 ml	111.3f-k	12.7a	3.9c
No weeding	195.3a	5.7b	1.8e
1.3 million plants ha^{-1}			
Hand weeding	110.3g-k	12.7 a	4.0bc
Roanstar @ 10 ml	125.3d-h	12.6a	4.0bc
No weeding	164.7b	6.0b	2.0de
One million plants ha^{-1}			
Hand weeding	65.33m	14.0a	4.6a
Roanstar @ 10 ml	72.33m	13.7a	4.7a
No weeding	114.3e-j	7.7b	2.1de
0.8 million plants ha^{-1}			
Hand weeding	107.0i-l	12.8a	4.6a
Roanstar @ 10 ml	129.0d-f	12.9a	4.6a
No weeding	141.3cd	6.7b	2.2de
0.67 million plants ha^{-1}			
Hand weeding	96.0kl	13.3a	4.6a
Roanstar @ 10 ml	90.7l	13.3a	4.6a
No weeding	129.3de	8.0 b	2.1de
0.53 million plants ha^{-1}			
Hand weeding	128.0d-g	11.8 a	4.7a
Roanstar @ 10 ml	127.3d-h	12.5a	4.4ab
No weeding	138.7d	7.0b	2.2de
0.44 million plants ha^{-1}			
Hand weeding	99.3j-l	12.4a	4.6a
Roanstar @ 10 ml	126.7d-h	12.3a	4.6a
No weeding	163.0b	6.8b	2.2d
LSD (0.05)	17.82	3.05	0.42

Bulb yield: Significant differences (P=0.05) were recorded in yield of different treatments. The highest and lowest yield were recorded in treatments where the plant density was 2 million ha^{-1} but weeding was done in the first and no weeding in the second case (Table 1). Difference between the highest and lowest yield was 60.4%. The yield in one treatment with lowest AUDPC was at par statistically with that of highest yield inspite of the fact that the plant density of the former was half that of the latter. This may be attributed to low severity of rust in this treatment. It seemed that the long- held concept of attaining high yield, with high plant population did not work in this case, as the number of healthy rather than total plants was necessary for minimizing yield losses. In majority of cases, treatments that did not involve weed control showed low yields. Apparently weeds used most of the nutrients and subsequently decreased garlic yield.

Bulb index: Bulb index in different treatments differed significantly (P = 0.05) from one another. The greatest bulbs index was recorded in treatment where plant population was one million ha^{-1} and weeds were killed with herbicide Roanstar. It was closely followed by treatment with lowest AUDPC and having plant density as in the former treatment but with manual weeding. Both treatments showed nonsignificant differences (Table 1). Treatments that yielded small sized bulbs either had high plant density or had no weeding. High plant population and more and different types of weeds reduced bulb size through competition for space and nutrients and more susceptibility to the disease.

The comparatively better performance of the treatment having plant density of one million ha^{-1} and manual weeding in controlling rust and giving acceptable yield has indicated that this cultural control shall becuased on large scale to ensure rust control and high production in garlic.

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