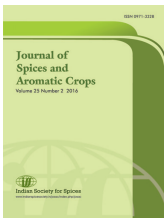
Journal of Spices and Aromatic Crops
Vol. 25 (2) : 182–186 (2016)
www.indianspicesociety.in/josac/index.php/josac

Indian Society for Spices



Earliness, yield and bulb parameters of hardneck garlic (*Allium sativum* L.) as influenced by leaf knotting and scape removal in north Indian plains

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Received 08 February 2016; Revised 11 April 2016; Accepted 01 June 2016

Abstract

The present study was conducted during *Rabi* 2012–13 and 2013–14 to estimate the effect of scape removal, leaf knotting 4 weeks before harvest and leaf knotting 2 weeks before harvest on earliness, yield and bulb parameters of hardneck garlic cultivar 'PG-17' in north western plains of India. The removal of scapes has no effect on reduction in days to maturity, equatorial diameter of bulb, bulb weight, number of cloves per bulb and cured bulb yield as compared to control. The knotting of leaves 4 and 2 weeks before harvest advanced maturity by 12 and 6 days, respectively, over control. Leaf knotting 4 weeks before harvest significantly decreased equatorial diameter of bulb, bulb weight and cured bulb yield, whereas, leaf knotting 2 weeks before harvest caused non-significant reduction in equatorial diameter of bulb, bulb weight, number of cloves per bulb, 50-clove weight and cured bulb yield as compared to control. It is therefore advisable that the practice of leaf knotting may be omitted to save labour charges, whereas the practice of scape removal in hardneck garlic cultivars should be exercised only after studying the response of that particular cultivar to scape removal.

Keywords: *Allium sativum*, flower stalk, hardneck, leaf knotting, scape

Introduction

Garlic (*Allium sativum* L.) is one of the most important condiment crops of India and the world. Among various continents, Asia is the largest producer of garlic and accounts for 91.7% of global garlic production. India is the second largest producer of garlic in the world after China which produced 19.17 million tonnes during 2013. In India, the crop was cultivated over 0.248 million hectare in 2013 producing 1.259 million tonnes of garlic with an average productivity of 5.077 tonnes ha^{-1} (FAO 2015). There are two general categories of garlic i.e. softneck and hardneck. The clones which do not produce a flower stalk or scape are termed "softneck" or "non-bolting types". On the contrary, the clones adapted to colder climates produce a scape and are termed "hardneck" or "bolting types" (Rosen & Tong 2001). In hardneck garlic, Orlowski *et al*. (1994) had reported significant yield increases when scapes were removed compared with leaving scapes on until harvest. Rosen & Tong (2001) observed that scape removal resulted in a 15% and 5%

increase in bulb yield at low and high organic matter site, respectively, but the effect of scape removal on bulb weight loss was non-significant at either location. Secondly, one of the practices in some parts of India and particularly in North India is to knot garlic leaves towards maturity i.e. 15 to 20 days before harvest. Ganguly & Bansal (2010) conducted an experiment at Palampur and reported that knotting of garlic leaves two weeks before harvest increased polar and equatorial diameter of bulb, bulb weight, bulb yield, induced early maturity and showed maximum moisture loss during storage as compared to control. On the other hand, based on a study conducted at Palampur and Kullu, Sharma *et al*. (2010) observed that knotting of garlic leaves did not affect storage losses and suggested that labour charges may be saved by not using knotting practice. Keeping in view the shortage of studies on this aspect in plain zone, the present study was therefore conducted to assess the influence of scape removal and leaf knotting on earliness, yield and bulb parameters of hardneck garlic cultivar 'PG-17' in north-western plains of India.

Materials and methods

The present investigations were conducted at Regional Research Station, Punjab Agricultural University, Bathinda (30° 9′ 36′′ N, 74° 55′ 28″ E, 211 m above mean sea level) for two consecutive years i.e. *rabi* 2012–13 and 2013–14. The experimental field in first year was different from that in second year. There were four treatments *viz*., scape removal, leaf knotting 4 weeks before harvest, leaf knotting 2 weeks before harvest and control. These four treatments were replicated five times in a randomized complete block design (RCBD). Non-experimental plots were also sown on both sides of the experimental plots in each replication. The cloves of garlic cultivar 'PG-17' were sown at a spacing of 15 cm × 7.5 cm on 17th October, 2012 during first year and on 8th October, 2013 during second year. Net plot size was 2.60 m × 2.10 m. Each plot accommodated 14 rows and 34 cloves were planted in each row. Before sowing, well rotten farm yard manure was incorporated @ 50 tonnes ha^{-1} in to the soil and mixed well. Phosphorus @62.5 kg ha^{-1} was also added in to the soil as basal dose. In addition, a total of 125 kg ha^{-1} of nitrogen was added as top dressing in three equal splits at 30, 45 and 60 days after planting. The irrigation was applied at 14 days interval during winter and at 7 days interval during autumn, spring and summer months. The scapes started to emerge in third week of March and were cut immediately after their appearance in the treatment plots. Twelve competitive rows of bulbs leaving two border rows in each plot were harvested. The fresh harvested bulbs along with leaves were cured at room temperature for 30 days and bulb yield after curing was recorded after removing the leaves. Ten bulbs were randomly chosen and their equatorial diameter and weight was recorded with the help of a Vernier Calliper and electronic weighing balance, respectively. Afterwards, these ten bulbs were broken in to cloves which were counted to estimate number of cloves per bulb. Of these, fifty cloves were taken randomly and weighed on an electronic balance to estimate 50-clove weight (g). The data were analyzed for individual years and pooled over years for analysis of variance using computer software programme CPCS1.

Results and discussion

The mean sum of squares due to treatment was significant for days to maturity during first year and for all the traits except number of cloves per bulb and 50-clove weight during second year (Table 1). This meant that during first year of study, the treatments were at par for all the traits except days to maturity, whereas during second year of study, there were significant differences among treatments for all the traits except number of cloves per bulb and 50-clove weight. The pooled analysis (Table 1) showed that the mean sum of squares due to treatment was significant for all the traits except number of cloves per bulb and 50-clove weight. Treatment × Year interaction was significant for one trait, *viz*., bulb weight which meant that the performance of the treatments for this trait was significantly different during both the years whereas for other traits the performance of the

Table 1. Analysis of variance for earliness, yield and bulb parameters of garlic as influenced by leaf knotting and scape removal

Source of variation	df	Trait					
		Days to maturity	Equatorial diameter of bulb (cm)	Bulb weight(g)	No. of cloves bulb^{-1}	50-clove weight(g)	Cured bulb yield(t ha^{-1})
				Y_1			
Replication	4	8.55*	0.009	1.06	6.27*	2.11	0.589
Treatment	3	139.40*	0.002	0.28	0.40	0.23	0.063
Error	12	0.15	0.008	0.51	1.84	5.86	0.196
				Y_2			
Replication	4	2.55*	0.130*	4.27	9.88*	52.91*	2.975*
Treatment	3	146.73*	0.051*	11.46*	2.63	38.42	1.008*
Error	12	0.15	0.005	2.23	1.92	17.84	0.110
				Pooled			
Replication (within environment)	8	5.55*	0.070*	2.66	8.07*	27.51*	1.782*
Treatment (T)	3	285.79*	0.033*	7.29*	1.56	18.43	0.733*
Years (Y)	1	1000.00*	1.190*	167.85*	46.01*	931.61*	3.125*
Interaction (T × Y)	3	0.33	0.020	4.45*	1.47	20.22	0.338
Error	24	0.15	0.007	1.37	1.88	11.85	0.153

*denote significance at 5% level of significance
Y_1 = 2012–13, Y_2 = 2013–14

treatments was on a par during both the years. The variance due to years was significant for all the traits signifying the important role played by environment in the expression of these traits. The equatorial diameter of bulb, bulb weight, number of cloves bulb^{-1}, 50-clove weight and cured bulb yield of all treatments during second year were significantly higher than first year (Table 2) which may be due to timely sowing of the crop in second year as compared to a little late sowing in first year and differences in soil fertility status during these two years.

The removal of garlic scapes did not have any significant effect on days to maturity, equatorial diameter of bulb, bulb weight, number of cloves bulb^{-1}, 50-clove weight and cured bulb yield as compared to control during both the years of study and pooled over years (Table 2). These results are in contrast to those of Orlowski *et al.* (1994). The probable reason for the non-significant effect of scape removal on bulb yield and related traits may be non-responsiveness of the cultivar used in the present study as the effect of scape removal varies with the clone.

Table 2. Earliness, yield and bulb parameters of garlic as influenced by leaf knotting and scape removal

Treatment	Days to maturity			Equatorial diameter of bulb (cm)			Bulb weight (g)		
	Y_1	Y_2	Pooled	Y_1	Y_2	Pooled	Y_1	Y_2	Pooled
Scape removal	187.2	197.4	192.3	3.17	3.58	3.38	13.35	18.03	15.69
Leaf knotting 4 weeks before harvest	176.8	186.4	181.6	3.16	3.37	3.26	13.01	15.11	14.06
Leaf knotting 2 weeks before harvest	182.4	192.8	187.6	3.15	3.51	3.33	13.19	18.07	15.63
Control	188.4	198.2	193.3	3.20	3.59	3.39	13.57	18.30	15.93
Mean	183.7	193.7	188.7	3.17	3.51	3.34	13.28	17.38	15.33
CD (T) (P<0.05)	0.5	0.5	0.4	NS	0.10	0.07	NS	2.06	1.08
CD (Y) (P<0.05)			0.2			0.05			0.76
CD (T × Y) (P<0.05)			NS			NS			1.53

Y_1 = 2012–13, Y_2 = 2013–14

Contd.

Treatment	No. of cloves bulb^{-1}			50-clove weight (g)			Cured bulb yield (t ha^{-1})		
	Y_1	Y_2	Pooled	Y_1	Y_2	Pooled	Y_1	Y_2	Pooled
Scape removal	23.78	25.42	24.60	43.34	54.41	48.88	5.68	6.16	5.92
Leaf knotting 4 weeks before harvest	23.18	25.40	24.29	43.57	48.96	46.27	5.47	5.54	5.51
Leaf knotting 2 weeks before harvest	23.78	25.30	24.54	43.24	54.53	48.88	5.57	6.43	6.00
Control	23.62	26.82	25.22	43.72	54.58	49.15	5.72	6.55	6.14
Mean	23.59	25.74	24.66	43.47	53.12	48.29	5.61	6.17	5.89
CD (T) (P<0.05)	NS	NS	NS	NS	NS	NS	NS	0.46	0.36
CD (Y) (P<0.05)			0.90			2.25			0.25
CD (T × Y) (P<0.05)			NS			NS			NS

Y_1 = 2012–13, Y_2 = 2013–14

The leaf knotting practice was quite effective in advancing maturity of garlic bulbs. Knotting of leaves 4 and 2 weeks before harvest induced early maturity by 12 and 6 days, respectively over control (Table 2). These results are in agreement with those of Ganguly & Bansal (2010). This may be due to faster translocation of carbohydrates from leaves to bulbs and forcing the plants towards senescence.

On the other hand, the effect of leaf knotting practice on bulb yield and related traits was not favourable. Leaf knotting 4 weeks before harvest significantly decreased equatorial diameter of bulb, bulb weight and cured bulb yield by 3.83%, 11.74% and 10.26%, respectively as compared to control. However, the effect on number of cloves bulb^{-1} and 50-clove weight was non-significant. Whereas, leaf knotting 2 weeks before harvest had non-significant effect on equatorial diameter of bulb, bulb weight, number of cloves bulb^{-1}, 50-clove weight and cured bulb yield as compared to control although the numerical values were lowered by this treatment for most of the traits. These results are in contrast to those of Ganguly & Bansal (2010). Significant reduction in bulb yield and related traits by knotting of leaves 4 weeks before harvest may be attributed to less translocation of photosynthates from leaves to bulb in comparatively less number of days due to induction of early maturity.

It may therefore be concluded from the present study that the labour charges incurred on leaf knotting practiced in some parts of India may be saved as this practice does not improve bulb yield and related traits except inducing early maturity. On the other hand, the practice of scape removal in hardneck garlic cultivars should be exercised only after studying the response of that particular cultivar to scape removal.

Acknowledgements

The senior author is grateful to Dr. Akhilesh Sharma, Professor, Department of Vegetable Science and Floriculture, CSK Himachal Pradesh Agricultural University, Palampur, Himachal Pradesh, for providing technical guidance and photographs regarding leaf knotting practice in garlic. The senior author is also thankful to Prof. Carl J. Rosen, Head, Department of Soil, Water and Climate, University of Minnesota, St. Paul, MN, for sharing his research experiences regarding the practice of scape removal in garlic.

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