INDIAN JOURNAL OF
ARID HORTICULTURE
2018, Vol. 13 (1-2):94-97

Effect of NAA and thiourea on growth, yield and quality of garlic (*Allium sativum* L.)

Suman Choudhary[*1], M. R. Choudhary[1] and A. K Verma[2]
[1]Department of Horticulture, S. K. N. College of Agricultu.re, Jobner, Rajasthan
[2]ICAR-Central Institute for Arid Horticulture, Bikaner
[*]Corresponding author email: manbhar80@gmail.com
(Received: 25.08.2018; Accepted: 5.10.2018)

Abstract

A field experiment was conducted to study the "Effect of NAA and thiourea on growth, yield and quality of Garlic (*Allium sativum* L.)" during the *rabi* season, 2017-18 at the Horticulture Farm, S.K.N. College of Agriculture, Jobner (Rajasthan). The experiment consisted of twenty treatment combinations including five NAA and Thiourea levels (control, NAA @ 100 ppm, NAA @ 200 ppm, Thiourea @ 100 ppm and Thiourea @ 200 ppm). They were under taken in factorial randomized block design with three replications. The results of the study clearly indicated that foliar application of thiourea @ 200 ppm to the garlic crop significantly increased the plant height (cm), number of leaves per plant, chlorophyll content in leaves, fresh weight of leaves, neck thickness, polar diameter, fresh weight of bulb, number of cloves per bulb, bulb yield (134.58 q/ha) and quality attributes *viz*., TSS, sulphur, protein content, nitrogen content and ascorbic acid) and net returns (Rs. 1,08,062 /ha) and B: C ratio (1.34) as compared to control.

Key words: NAA, thiourea, growth, yield, garlic

Introduction

Botanically, garlic is known as *Allium sativum* L. which belongs to the family Amaryllidaceae. It is a multiple or compound bulb consists of smaller bulblets called 'cloves' and is surrounded by a thin white or pinkish papery sheath. The economic yield is obtained from these cloves. It is the second important bulb crop after onion. Garlic has higher nutritive value than other bulb crops. It is specially rich in protein, carbohydrate and ascorbic acid. About 142 calories of energy is obtained from 100 g of garlic. Garlic is used in flavoring of foods, preparing chutneys, pickles, curry powder, tomato ketchup, etc. It also contains phosphorus, potash, calcium, magnesium, carbohydrates and a colourless as well as odourless water soluble amino acid called 'allin'. On crushing the cloves, an enzyme allinase acts upon allin and breaks down to produce allicin. The principal ingredient of which is odoriferous diallyl-disulphide, which is the major flavouring component of garlic. Garlic also contains about 0.1 per cent volatile oil and the green garlic is rich in ascorbic acid. India ranks second in area and third in production of garlic in the world. The productivity of this crop is quite low *i.e*. 5.09 tonnes per hectare (Gupta, 2014) which is far less than that of China and Egypt. In India, garlic is cultivated throughout the country occupying an area of 261 thousand hectare with production of 1400 thousand MT (Anonymous, 2015). In India, the major garlic producing states are Madhya Pradesh, Odissa, Rajasthan, Karnataka and Gujarat (Anonymous, 2015). In Rajasthan, it is grown extensively in Chittorgarh, Baran, Jodhpur, Jhalawar, Kota, Bundi, Jaipur and Sikar districts. Availability of garlic in India is only 6.34 kg/year/capita in comparison to 11.14 kg / year/capita of Korean republic. This situation of the crop in India may be due to its unscientific cultivation and lesser care of growers to its nutritional management (Anonymous, 2011).

Plant growth regulator presents a new possibility to break yield barrier, particularly imposed by the environment. Application of growth regulators at a specific or critical growth stage influences the key processes of plants favouring manipulation of protein content of the crop. The application of triacontanol (a long chain aliphatic alcohol) based plant growth regulators and naphthalene acetic acid (NAA) has been reported to induce physiological efficiencies including photosynthetic ability of plants which resulted in better growth and yield of several crop without substantial increase in cost of production (Sumeriya *et al.*, 2000). Naphthalene acetic acid (NAA) is a synthetic auxin, can bring changes in the phenotype of plants and affect growth either by enhancing or by stimulating the natural growth regulatory systems from seed germination to senescence (Das and Das, 1995). NAA (Naphthalene acetic acid) stimulates cell elongation, cell division in the cambium, differentiation of phloem and xylem and induce flowering. The effect of NAA on plant growth is greatly dependent on the time of application and its concentration. NAA play a vital role for modifying the growth behaviour of plant resulting in increase in growth rate of shoot and root and finally increase yield (Patil and Patel, 2010). It plays a key role in root and shoots development, promoting the germination of seeds and inducing the flower buds. Thiourea is

a sulphydryl compound which contains one-SH group besides containing nitrogen in the form of NH_2. It plays a vital role in the physiology of plants both as a sulphydryl compound and to some extent as an amino compound like urea. The stimulating action of thiourea in various physiological activities of plant is well known. It has been proved effective in mitigating drought in clusterbean and mothbean. It promotes growth in cytokinin requiring callus tissues in absence of kinetin in various crops. Kolyada (1970) noticed significant increase in germination and seedling vigour after soaking of seeds of sugarbeet in 10 ppm thiourea solution. It has also been reported that thiourea regulates the plant growth by maintaining higher photosynthetic rate upto the reproductive stage and increased the yield improving carbon partitioning towards sink. Thiourea is mainly known for its dormancy breaking and germination stimulating effect. Keeping these points in view, the present investigation entitled "Effect of NAA and thiourea on growth, yield and quality of garlic (*Allium sativum* L.)" was therefore carried out to find out the effect of NAA and thiourea on growth, yield and quality of garlic.

Materials and Methods

The field experiment entitled "Effect of varying levels of nitrogen on growth, yield and quality of garlic (*Allium sativum* L.)" was conducted at the Horticulture farm and quality observations recorded at Laboratory of Department of Horticulture, S. K. N. College of Agriculture, Jobner during the *rabi* season, 2017-18. The experiment was laid out at the Horticulture farm, S. K. N. College of Agriculture, Jobner during *rabi* season 2017-18. Jobner is situated at 26°05 ' North latitude, 75°28 ' East longitude and an altitude of 427 meters above mean sea level in Jaipur district of Rajasthan. The experiment was laid out in randomized block design with three replications. Four levels of nitrogen treatments were taken. The treatments were randomly allotted to different plots using random number table of Fisher and Yates (1963). The experimental field was thoroughly ploughed and cross-ploughed with the help of mould board plough and cross-harrowing was done with tractor, followed by planking and levelling to bring the field to a good tilth. Beds of 1.5 m x 1.2 m size and paths and channels were also prepared according to the layout of the experiment.

The seeds of cv G-41 procured from NHRDF, Karnal (Haryana). The seeds of garlic were first treated with bavistin @ 2 g per kg seed to control seed borne diseases. The seeds were sown in row at 15 cm apart on 14th November 2017 by hand dibbling method and 10 cm spacing within the row was maintained. Phosphorus, potash and sulphur dose were applied uniformly in all plots as per recommended dose of P, K and S as basal dose only. The experiment was comprised of five levels of NAA and Thiourea. Two foliar spray of NAA @ 100 and 200 ppm and thiourea @ 100 and 200 ppm through planofix (4.5%) and thiourea (99.9%), respectively were done at 20 and 40 DAS using 500 litres water per spray per hectare. NAA is a synthetic auxin and its empirical formula is $C_{12}H_{10}O_2$. Thiourea is a sulphydryl compound and as an amino compound and its empirical formula is CH_4N_2S. In order to evaluate the effect of NAA and thiourea on growth, yield and quality of crop, periodical observations on various growth and yield parameters were recorded.

Results and Discussion

Effect of NAA and thiourea on growth parameters

The application of different growth regulators had favourable effect on growth. The data (Table 1) showed that foliar application of thiourea @ 200 ppm significantly increased the plant height, number of leaves per plant, cholorophyll content in leaves, fresh weight of leaves of garlic followed by thiourea @ 100 ppm, being *statistically* at par with each other. This may be due to the effect of chemicals on cell division and cell elongation during plant growth stage (Haldar *et al*., 2012). Thiourea is a good source of nitrogen and sulfur which promotes vegetative growth of the plant. The favourable effect of thiourea on plant growth might be due to improved photosynthetic efficiency and bio-regulatory role in plants. Nitrogen increases chlorophyll content in leaves thus, resulting in higher photosynthetic rate and higher vegetative growth of the plant (Pooja Rani *et al*., 2015; Nagar *et al*., 2017). Thiourea treated crop showed more chlorophyll content for photosynthate preparation and translocation towards sink. This might have been due to improved phloem loading of assimilates under the influence of thiourea spray, most probably on account of SH-group present in thiourea molecules. The SH-group stimulated the photosynthetic carbon fixation mechanism and hence, foliar spray of thiourea might have increased the plant height, number of leaves and chlorophyll content, which ultimately resulted in higher vegetative growth of garlic plants. Similar results were also reported by Solanki and Sahu (2007) in clusterbean and Meena (2011) in coriander.

Effect of NAA and thiourea on yield parameters

Application of different growth regulators

Table 1. Effect of NAA, thiourea on growth parameters of garlic

Treatments	Plant height (cm)	Number of leaves per plant	Total chlorophyll content (mg/g)	Fresh leaves weight (g)
P_0 Control	34.54	6.50	0.709	18.58
P_1- NAA 100 ppm	37.68	7.72	0.899	21.02
P_2- NAA 200 ppm	39.26	8.64	0.954	21.36
P_3- Thiourea 100 ppm	40.72	8.97	1.008	23.09
P_4- Thiourea 200 ppm	42.18	9.53	1.117	23.59
SEm±	1.00	0.27	0.026	0.65
CD (P = 0.05)	2.86	0.76	0.073	1.85

significantly increased the neck thickness, polar diameter, fresh weight of bulb, number of cloves per bulb and bulb yield. The data (Table 2) showed that application of thiourea @ 200 ppm followed by thiourea @ 100 ppm being at par to each other significantly enhanced all the above yield parameters, over control and NAA levels. The increase in yield attributes with the application of thiourea might be because of better utilization of the sources in the plants. An increase in yield attributing characters with foliar application of thiourea might have induced large number of reproductive sinks leading to greater activity of carboxylating enzymes resulting in higher photosynthetic rates with greater translocation and accumulation of metabolites in sink and ultimately higher yield (Nehra *et al*., 2006; Balai *et al.*, 2017). Similar response with foliar spray of thiourea was also recorded by Balai and Keshwa (2011), Shanu *et al*. (2013) in coriander and Gupta and Yadav (2009) in fenugreek. This stimulatory effect may be occurred with foliar application which might have transferred to roots and finally resulting an increase in organic acid and protons efflux. This can increase the uptake of ions such as nitrogen and phosphorus by plants, which ultimately enhance yield and yield attributes (Maleki *et al*., 2013; Meena and Bhati, 2016). The obtained results are in agreement with the result of Jaafari and Hadavi (2012a & b). The increase in yield attributes and yield with foliar application of thiourea was most probably due to increase in crop photosynthesis favoured by both improved photosynthetic efficiency and source to sink relationship. Similar response with foliar spray of thiourea was also recorded by Balai and Keshwa (2010) and Bochalia *et al*. (2011) in fenugreek.

Effect of NAA and thiourea on quality parameters

Results revealed that TSS content, crude protein content, sulphur content, N content and ascorbic acid in garlic influenced by application of different growth regulators. Quality parameters were significantly increased with the application of thiourea @ 200 ppm (Table 3) being statistically at par with thiourea @ 100 ppm. The increased accumulation of nutrients especially N, P and Zn in vegetative parts concomitant the improved metabolism led to greater translocation of these nutrients to reproductive structure of crop. Application of thiourea resulted in better utilization of nitrogen and phosphorus in plants probably due to the fact that application of thiourea might have helped in improved metabolic process of plants and better growth & development leading to greater absorption of nutrients from rhizosphere, Solanki (2002) reported that thiourea being a sulphydryl compound significantly improved the root growth in clusterbean crop. This might be due to metabolic role of SH group in root physiology and biochemistry. The findings of present experiment are also in close conformity with those of Haldar *et al*. (2012) in garlic and Mani *et al*. (2013) in potato.

It is apparent from data that net returns of garlic crop influenced significantly with foliar spray of different growth regulators. The maximum net returns Rs.1,08,062 per hectare was recorded under treatment P_4 (Thiourea @ 200 ppm) followed by P_3 (Rs. 1,03,372 /ha), being statistically at par with each other and found significantly superior over control, P_1 and P_2. The increase in net returns under treatment P_4 was found to be 200.23, 38.58 and 16.50 per cent higher as

Table 2. Effect of NAA, thiourea on yield parameters of garlic

Treatments	Neck thickness (cm)	Polar diameter (cm)	Av. weight of bulb (g)	No. of cloves	Bulb yield (kg/plot)	Bulb yield (q/ha)
P_0 - Control	0.65	2.56	26.28	16.41	1.48	82.43
P_1- NAA 100 ppm	0.78	3.50	38.77	18.27	2.04	113.27
P_2- NAA 200 ppm	0.80	3.59	39.78	18.42	2.23	123.92
P_3- Thiourea 100 ppm	0.82	3.76	49.68	20.20	2.36	131.21
P_4- Thiourea 200 ppm	0.87	3.94	50.69	20.42	2.42	134.58
SEm±	0.02	0.09	0.44	0.60	0.03	1.59
CD (P = 0.05)	0.06	0.27	1.24	1.73	0.08	4.55

Table 3. Effect of NAA, thiourea on quality parameters of garlic

Treatments	TSS (%)	S content (mg/kg)	N content (%)	Protein content (%)	Ascorbic acid (mg/100g)
P_0 - Control	35.63	1.21	0.842	5.26	8.30
P_1- NAA 100 ppm	38.65	1.35	0.987	6.17	11.23
P_2- NAA 200 ppm	38.93	1.40	1.006	6.29	11.43
P_3- Thiourea 100 ppm	39.37	1.51	1.118	6.99	13.72
P_4- Thiourea 200 ppm	41.74	1.55	1.126	7.04	13.79
SEm±	1.03	0.04	0.024	0.18	0.37
CD (P = 0.05)	2.95	0.11	0.069	0.53	1.06

compared to control, P_1 (NAA @ 100 ppm) and P_2 (NAA @ 200 ppm), respectively.

References

Anonymous. 2011.Indian Horticulture Database, Publication from National Horticulture Board, Gurgaon, pp.58-61.

Anonymous. 2015. Estimate of Area and Production of Horticulture Crops (2015-2016) 3rd Advance. Ministry of Agriculture, Government of India 85, Institutional Area, Sector-18, Gurgaon, Haryana.

Balai, L.R. and Keshwa, G.L. 2011. Effect of thiourea on yield and nutrient uptake of coriander (*Coriandrum sativum* L.) varieties under normal and late sown conditions. *Journal of Spice and Aromatic Crops*, 20 (1): 34-37.

Balai, R.C., Meena, L.R. and Sharma, S.C. 2017. Effect of different levels of nitrogen and phosphorus on cowpea [*Vigna unguiculata* (L.) Walp] under rainfed conditions of Rajasthan. *Journal of Agriculture and Ecology*, 3: 19-24.

Bochalia, G.C., Tiwari, R.C., Ram, B., Kantwa, S.R. and Choudhari, A.C. 2011. Response of fenugreek (*Trigonella foenum-graecum* L.) genotypes to planting geometry, agro-chemicals and sulphur levels. *Indian Journal of Agronomy*, 56 (3): 273-279.

Das, B.C. and Das, T.K. 1995. Efficiency of GA_3, NAA and Ethrel on seed expression in pumpkin (*Cucurbita moschata* Poir.) cv. Guamala Local. *Orissa Journal of Horticulture*, 28: 293-295.

Fisher, R.A. and Yates, F. 1963. Statistical Tables. Oliver and Boyd, Edinburgh, London.

Gupta, D.K. and Yadav, S.S. 2009. Response of fenugreek to varying levels of sulphur and bio-regulators. Published by S.K.N. College of Agriculture in National seminar on Spices and Aromatic plants in 21st century India, pp. 67.

Haldar, A., Naruka, I.S., Singh, P.P. and Rathore, S. 2012. Effect of antioxidants on growth, yield and quality of garlic (*Allium sativum* L.). *International Journal of Phytomedicines and Related Industries*, 4 (4): 206-211.

Jaafari, N. and Hadavi, E. 2012a. Growth and essential oil yield of Basil (*Ocimum basilicum* L.) as affected by foliar spray of citric acid and salicylic acid. *Journal of Medicinal and Spices Plants*, 17(2): 80-83.

Jaafari, N. and Hadavi, E. 2012b. Growth and essential oil yield of Dill (*Anethum graveolens*) as affected by foliar sprays of citric acid and malic acid. *Acta Horticulturae*, 9(55):287-290.

Kolyada, T.I. 1970. Effect of thiourea on seed germination and plant growth. *Byul uses. Inst. Sel*. Khoz Mikrolbiol, 3: 74-81 (*Field crop Abstr*acts, 24: 5383).

Maleki, V., Ardakani, M.R., Rejali, F. and Taherpour, A.A. 2013. Physiological response of Sweet basil to triple inoculation with Azotobacter, Azospirillum, Glomus interaradices and foliar application of citric acid. *Annals of Biological Research*, 4(1): 62-71.

Mani, F., Bettaieb, T., Zheni, K., Doudech, N. and Hannachi, C. 2013. Effect of thiourea on yield and quality of Potato (*Solanum tuberosum* L.). *Journal of Stress Physiology & Biochemistry*, 9 (1): 87.

Meena, N.K. and Bhati, A. 2016. Response of Nitrogen, Phosphorous and Potassium Levels on Growth and Yield of Okra [*Abelmoschus esculentus* (L.) Moench.]. *Journal of Agriculture and Ecology*, 2: 17-24.

Meena, S.K. 2011. Effect of plant growth regulators and sulphur on productivity of Coriander (*Coriandrum sativum* L.). M.Sc. (Ag.) Thesis, Swami Keshwanand Rajasthan Agricultural University, Bikaner.

Nagar, M., Soni, A.K., Sarolia, D.K. and Saini, H.R. 2017. Effect of organic manures and different levels of NPK on growth and quality of bottle gourd [*Lagenaria siceraria* (Mol.) Standl.]. *Journal of Agriculture and Ecology*, 4: 44-50.

Nehra, K.C, Kumawat, P.D. and Singh, B.P. 2006. Response of fenugreek (*Trigonella foenum-graecum*) to phosphorus, sulphur and plant growth regulators under semi arid plains zone of Rajasthan. *Indian Journal of Agronomy*, 51(1): 73-76.

Patel, J.J. and Patel, A.T. 1990. Effect of nitrogen and phosphorus levels on growth and yield of onion (*Allium cepa L.*) cultivar Pusa Red. *Gujarat Agricultural University, Journal of Research.* 15: 1-5.

Pooja Rani, Panghal, V.P.S., Rao, M.K. and Dushan, D.S. 2015. Response of garlic to foliar application of urea and micronutrients. *International Journal of Tropical Agriculture*, 33(4): 2845-2849.

Shanu, I.S., Singh, P.P, Shaktawat, R.P.S. and Verma K.S. 2013. Effect of seed treatment and foliar spray of thiourea on growth, yield and quality of coriander (*Coriandrum sativum* L.) under different irrigation levels. *International Journal of Seed Spices*, 3(1): 20-25.

Solanki, N.S. 2002. Effect of thiourea and dimethyl sulphoxide on phosphorus use efficiency, dry matter partitioning and productivity of cluster bean (*Cyamopsistetragonoloba L.)*.Ph.D. Thesis, Maharana Pratap University of Agriculture and Technology, Udaipur.

Sumeriya, H.K., Meena, N.L. and Mali, A.L. 2000. Effect of phosphorus, triacontanol granule and growth promoters on the productivity of mustard [*Brassica juncea* (L.)Czern and Coss]. *International Journal of Tropical Agriculture*, 18 (3): 283-286.