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YR Shukla
Department of Vegetable Science, Dr. Y S Parmar University of Horticulture and Forestry, Nauni-Solan, Himachal Pradesh, India

Manisha Kaushal
Department of Vegetable Science, Dr. Y S Parmar University of Horticulture and Forestry, Nauni-Solan, Himachal Pradesh, India

Shilpa
Department of Vegetable Science, Dr. Y S Parmar University of Horticulture and Forestry, Nauni-Solan, Himachal Pradesh, India

Correspondence
YR Shukla
Department of Vegetable Science, Dr. Y S Parmar University of Horticulture and Forestry, Nauni-Solan, Himachal Pradesh, India

Effect of macro and micro nutrients on quality characters, disease severity and yield of garlic (*Allium sativum* L.)

YR Shukla, Manisha Kaushal and Shilpa

Abstract
The present investigation entitled "Studies on macro and micro nutrients on yield and quality of garlic (*Allium sativum* L.)" was conducted during *Rabi* season of 2015-16 at Horticultural Research and Training Station and KVK, Kandaghat of Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan. Ten combinations of different macro and micro nutrients were replicated thrice in the form of ten treatments in a plot having dimensions of 2.0x2.0m. The experiment was laid out in a randomized block design with three replications involving a spacing of 20x10cm. The cloves of garlic variety 'Kandaghat Selection' were sown on 1st October, 2015. The data were recorded on weight of 100 unpeeled and peeled cloves (g), bulb yield per hectare (q), peeling index (%), dry matter content (%), oleoresin content (%) and disease severity (%). The results revealed that application of 125% of recommended dose of NPK + Zn @ 7.5kg/ha produced best results in terms of characters like weight of 100 unpeeled and peeled cloves (g), bulb yield per plot (kg) and per hectare (q), peeling index (%), dry matter content (%), oleoresin content (%) whereas, minimum values for all these characters were recorded in the absolute control. Minimum disease severity (%) was found in T_{10}. It was concluded that application of 125% of recommended dose of NPK + Zn @ 7.5kg/ha gave better results and hence, can be recommended for harvesting maximum yield from garlic after repeating the experiment for another two years.

Keywords: Macro and micro nutrients, garlic, yield and disease severity

Introduction
Garlic (*Allium sativum* L.) is the most widely used cultivated *Allium* species after onion belonging to the family Amaryllidaceae. Garlic is cultivated all over India mainly in Gujarat, Orissa, Madhya Pradesh, Rajasthan, Uttar Pradesh and Maharashtra. It is consumed both fresh as well as in dried forms as an important ingredient for flavouring various vegetarian and non-vegetarian dishes. In the Indian sub-continent, people use fresh leaves of garlic as salad and a tasty pickle is also prepared from its cloves. Garlic has higher nutritive value as compared to other bulbous crops. It is a rich source of carbohydrates (29.0%), proteins (6.3%), minerals (0.3%), essential oils (0.1 – 0.4 %) and also contains appreciable quantities of fats, vitamin C and sulphur (Memane *et al.*, 2008) [4]. Garlic has several medicinal properties and its reputation as a medicine has increased to such an extent that garlic oil capsules are now marketed through pharmacies and health food stores (Rahim and Fordham, 1994) [6]. Despite its importance and increased production, garlic productivity in many parts of the world is low due to genetic and environmental factors affecting its yield and yield related traits (Nonnecke, 1989).

Material and Methods
'Kandaghat Selection' variety was choosen for the studies. It is a local clonal selection from Himachal Pradesh. The plants are of long day type. Bulbs are creamish white having diameter ranging from 3.5-5.5cm. Bulbs have 13-16 yellowish white cloves having diameter of 1.1-1.7cm. The cultivar is suitable for cultivation in Northern hilly regions of India. It is a medium storer and tolerant to common diseases. Average yield per hectare range from 140-200 q/ha. The experiment was laid out in randomized block design with three replications and ten treatments. The plot size was taken 2.0 x 2.0 m with spacing of 20 x 10 cm and total number of plots was thirty.
The soil had 7.11 and 0.40 of pH, electrical conductivity respectively. The soil had fertility status of 279.25 kg nitrogen/ha, 30.25 kg phosphorus/ka and 355.28 kg potassium/ha. Annual precipitation of the area is 1120mm, which is received during monsoon (June- September).

Results and Discussion

Maximum values for weight of 100 unpeeled and peeled cloves were 377.66g and 347.00g, respectively (Table 1). The next best treatments for both these characters were T_9 (373.66g and 339g) and T_7 (368g and 335g), both showed significant differences with T_{10}. On the other hand peeing index, was, however more (91.88%) in T_{10} but this treatment showed non-significant effects with T_6 (91.17%) and T_8 (91.03%). It is clear from the present findings that there was direct and significant effect of different combinations of nutrients on weight of unpeeled and peeled cloves. The present findings are in line with those of Farooqui *et al*. (2009) [2] who also observed almost similar results under Mandsaur conditions probably due to more vegetative growth and more efficient use of available inputs due to adequate supply of nitrogen which finally resulted in higher productivity.

Dry matter content of the bulbs is one of the most important parameters as it is directly correlated with the yield. In the present findings, dry matter content was more 44.90 per cent in the treatment involving maximum content of N, P, K and Zn i.e. T_{10} (125% recommended dose of NPK + Zn @ 7.5 kg/ha). This was significantly superior over rest of the treatments. An adequate supply of nitrogen is associated with vigorous vegetative growth and more efficient use of available inputs finally leading to higher productivity. Similar are the findings of Girarden *et al*. (1985) [3] who also observed increase in dry matter content of crop with the application of optimum nitrogen along with other fertilizers probably due to increase in photosynthetic rate which is directly correlated with chlorophyll content of plant cell.

Oleoresin content was maximum (1.70%) in T_{10} (125% recommended dose of NPK + Zn @ 7.5 kg/ha) which showed significant differences with T_9 (1.61%), T8 (1.53%), T_6 (1.33%) and so on. The present findings are in line with those of Neerja and Korla (2010) [7] who clearly indicated that improved nitrogen metabolism particularly through nitrate reductase activity might have exerted higher values of quality characters including oleoresin content in ginger rhizomes.

Maximum disease severity (24.54%) was recorded in T_1 (absolute control) which was closely followed by T_2 (23.12%), T_3 (20.44%) and T_5 (20.31%). Minimum disease severity (13.99%) was, however recorded in T_{10} (125% recommended dose of NPK + Zn @ 7.5 kg/ha) i.e. the treatment which produced maximum yield of 197.25q/ha (Table 2). Similar are the findings of Mondal *et al*. (1989) [5] who reported that higher doses of nitrogen (150 or 200 kg urea/ hectare) in combination with higher doses of phosphorus (triple super phosphate) along with 80 kg of muriate of potash/hectare reduced the incidence of purple blotch of onion caused by *Alternaria porri* (Ellis) Cif.

The yield per plot was calculated by weighing all the marketable bulbs in a plot and was multiplied with a suitable factor to work out yield per hectare. In the present studies, per hectare yield ranged from 138.75q/ha (control plot) to 197.25q/ha in treatment T_{10} (125% recommended dose of NPK + Zn @ 7.5 kg/ha) which was 29.65 per cent more. The treatment which produced maximum yield i.e. $T_{10.}$ Assefa *et al*. (2015) [1] who also reported increased yield due to the application of N, P, S and Zn, possibly due to the combined effect of contribution of N to chlorophyll, enzymes and protein synthesis, as P is essential for root growth, phospho-proteins and phospho-lipids.

Table 1: Effect of macro and micro nutrients on quality characters and disease severity of garlic

Treatment code	Treatments	Weight of 100 unpeeled cloves (g)	Weight of 100 peeled cloves (g)	Peeling index (%)	Dry matter content (%)	Oleoresin content (%)	Disease severity (%)
T1	Absolute control	288.33	255	88.44 (9.46)*	36.19	0.65	24.54 (5.05)
T2	75% of RD of NPK	306.66	274	89.36 (9.51)	36.98	0.83	23.12 (4.90)
T3	75% of RD of NPK + Zn @ 5 kg/ha	318.33	285	89.72 (9.53)	38.64	1.05	20.44 (4.59)
T4	75% of RD of NPK + Zn @ 7.5 kg/ha	317.66	289	90.79 (9.58)	37.99	0.97	19.53 (4.51)
T5	RD of NPK	327.66	297	90.74 (9.58)	40.10	1.20	20.31 (4.60)
T6	RD of NPK + Zn @ 5 kg/ha	347.33	316	91.17 (9.60)	41.27	1.45	18.89 (4.43)
T7	RD of NPK + Zn @ 7.5 kg/ha	368.00	335	90.78 (9.58)	41.77	1.33	17.38 (4.26)
T8	125% of RD of NPK	358.00	325	91.03 (9.59)	44.02	1.53	16.25 (4.11)
T9	125% of RD of NPK + Zn @ 5 kg/ha	373.66	339	90.72 (9.58)	43.13	1.61	16.45 (4.15)
T10	125% of RD of NPK + Zn @ 7.5 kg/ha	377.66	347	91.88 (9.64)	44.90	1.70	13.99 (3.86)*
CD (0.05)		2.91	5.00	0.09	0.62	0.04	-

Table 2: Effect of macro and micro nutrients on bulb yield/plot (kg) and per hectare (q)

Treatment Code	Treatments	Bulb yield (kg/plot)	Bulb yield (q/ha)
T_1	Absolute control (No application of macro or micro nutrients)	6.17	138.75
T_2	75% of recommended dose of NPK.	7.03	158.25
T_3	75% of recommended dose of NPK + Zn @ 5 Kg/ha.	7.22	162.38
T_4	75% of recommended dose of NPK+ Zn @ 7.5 Kg/ha.	7.57	170.25
T_5	Recommended dose of NPK (100 % NPK).*	7.85	176.63
T_6	Recommended dose of NPK+ Zn @ 5 Kg/ha.	8.12	182.40
T_7	Recommended dose of NPK+ Zn @ 7.5 Kg/ha.	8.35	187.88
T_8	125% of recommended dose of NPK.	8.47	190.58
T_9	125% of recommended dose of NPK+ Zn @ 5 Kg/ha.	8.57	192.75
T_{10}	125% of recommended dose of NPK+ Zn @ 7.5 Kg/ha.	8.77	197.25
CD (0.05)		0.89	19.91

Conclusion

Regarding the performance of different treatments with regards to quality characters (oleoresin content and dry matter content), application of 125% of recommended dose of NPK + Zn @ 7.5kg/ha (T_{10}) produced best results. Absolute control (where there was no application of any macro and micro nutrients) produced minimum values for almost all the characters studied except disease severity.

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