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Effect on macro and micro nutrients on soil characters and yield of garlic (*Allium sativum* L.)

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Abstract
The present investigation entitled "Studies on macro and micro nutrients on soil characters and yield 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 2.0x2.0 m. The experiment was laid out in a randomized block design with three replications involving a spacing of 20x10 cm. The cloves of garlic variety 'Kandaghat Selection' were sown on 1st October, 2015. The data were recorded on bulb yield per hectare (q) and NPK content of the soil before start and after termination of experiment. The results revealed that application of 125% of recommended dose of NPK + Zn @ 7.5 kg/ha produced best results in terms of bulb yield per hectare (q) whereas, minimum values for these characters were recorded in the absolute control. Application of 125% of recommended dose of NPK + Zn @ 5kg/ha produced best results for characters like NPK content of the soil before start and after termination of experiment. 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: triclosan, TCS, determination, detection, sensor

Introduction
Garlic (*Allium sativum* L.) is the most widely used cultivated *Allium* species after onion belonging to the family Amaryllidaceae. Garlic is one of the main *Allium* vegetable crops known worldwide with respect to its production and economic value. Garlic is cultivated all over India mainly in Gujarat, Orissa, Madhya Pradesh, Rajasthan, Uttar Pradesh and Maharashtra. Modern agriculture largely depends on the use of chemical fertilizers. Imbalanced use of fertilizers leads to loss of soil fertility, causes soil degradation and has adverse effect on agricultural productivity. Reasons for low yield of garlic are mainly depletion of macro and micro nutrients from the soil, use of low yielding varieties with low or no inputs and poor management practices. The use of chemical fertilizer helps in achieving maximum yield of the crop. In many garlic producing areas, lack of available nutrients is frequently a limiting factor next to soil water as their uptake and liberation from soil depends upon availability of water. Both macro and micro nutrients have various roles to play in different soils and their removal by different crops vary with different seasons and areas. Balanced fertilizer application is essential for the vegetative growth and thus, for producing crops with top quality and high yields, especially on soils that are cultivated continuously. So there is a lot of scope to enhance the productivity in garlic through manipulation of various agronomic practices.

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).

Result and Discussion

The data recorded on available nitrogen content in soil showed that there was significant gain in available N content in soil due to the use of various combinations of macro and micro nutrients as compared to absolute control. The available nitrogen status of the soil declined in absolute control plots from its initial value of 279.25 kg/ha to 262.66 kg/ha (Table1). The reduction in available N in absolute control plots may be due to the cultivation of garlic crop without any addition of fertilizer, causing reduction in the available N status of the soil. These observations are in accordance with those of Bhardwaj and Omanwar (1994) [2] and Sheeba and Chellamuthu (1999) [10]. Maximum available N (424.19 kg/ha) content was recorded in the plots supplied with 125% of recommended dose of NPK+ Zn @ 5 kg/ha (T_9). Kumar (2004) [5] was also of the opinion that there is strong build up of available N in the soil with increased application of N in garlic crop. This may be due to increased activity of nitrogen fixing bacteria resulting in higher content of N in soil. Messick (2007) [4] were of the opinion that N application also help in its availability in the soil, uptake and concentration in the plant tissues.

The available P status of the soil declined in absolute control (T_1) treatment from its original value of 30.25 kg/ha to 28.26 kg /ha. Maximum available P (46.68 kg/ha) content was recorded in the plots supplied with of 125% of recommended dose of NPK + Zn @ 5 kg/ha (T_9) (Table1). Similar findings have also been reported by Prasad *et al*. (1996) [7] and Sharma *et al*. (2002) [9] in turmeric. The increase in available P status of the soil with increasing levels of different fertilizer nutrients like NPK and Zn may be due to lower utilization of P by the crop at higher levels of applied P, resulting in higher build up of soil phosphorus. Another reason for higher P status of soil could be due to adequate supply of P through fertilizers (Negi, 1986) [6].

The status of available K decreased from absolute control (340.09 kg/ha) than in those treatments where it was applied through chemical fertilizers when it was compared to initial K content (355.28 kg/ha). Maximum available K (493.69 kg/ha) was recorded in the plots supplied with 125% of recommended dose of NPK + Zn @ 5 kg/ha (T_9) (Table1). This could possibly be attributed to direct K addition in available K pool of soil (Tondon and Sekhon, 1988) [11]. Similar results were also reported by Rao and Swamy (1984) [8], Cardosa *et al*. (1993) [3] and Venkatesha *et al*. (1998) [12] in turmeric and by kumar (2004) [5] in garlic.

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 percent 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 different macro and micro nutrients on available nitrogen, phosphorus and potassium in soil after termination of experiment (kg/ha)

Treatment Code	Treatments	Bulb yield (q/ha)	Available N in soil (kg/ha)	Available P in soil (kg/ha)	Available K in soil (kg/ha)
T_1	Absolute control **(**No application of macro or micro nutrients**)**	138.75	262.66	28.26	340.09
T_2	75% of recommended dose of NPK.	158.25	316.64	29.15	365.45
T_3	75% of recommended dose of NPK + Zn @ 5 Kg/ha.	162.38	348.40	33.38	383.67
T_4	75% of recommended dose of NPK+ Zn @ 7.5 Kg/ha.	170.25	391.35	32.95	374.21
T_5	Recommended dose of NPK (100% NPK).*	176.63	383.17	41.61	419.16
T_6	Recommended dose of NPK+ Zn @ 5 Kg/ha.	182.40	406.58	40.20	446.82
T_7	Recommended dose of NPK+ Zn @ 7.5 Kg/ha.	187.88	416.21	45.51	454.42
T_8	125% of recommended dose of NPK.	190.58	418.94	43.39	477.02
T_9	125% of recommended dose of NPK+ Zn @ 5 Kg/ha.	192.75	424.19	46.68	493.69
T_{10}	125% of recommended dose of NPK+ Zn @ 7.5 Kg/ha.	197.25	419.26	46.27	491.49
$CD_{0.05}$					

Conclusion

Application of 125% of recommended dose of NPK + Zn @ 7.5kg/ha (T_{10}) gave the best performance over almost all other treatments for bulb yield/ha, but for available NPK in soil 125% of recommended dose of NPK+ Zn @ 5 Kg/ha (T_9) is best.

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