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Influence of Recommended Fertilizer Dose and Sulphur on Yield, Post-Harvest Losses and Economics of Garlic (Allium sativum L.) under On-Farm Conditions

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Abstract

An on-farm assessment trial (OFT) entitled "Influence of Recommended Fertilizer Dose and Sulphur on Yield, Post-Harvest Losses and Economics of Garlic (Allium sativum L.) under On-Farm Conditions" was conducted by KVK (ICAR-VPKAS)- Bageshwar, Kafligair, Uttarakhand in village Baidibagar situated at 29.7236° latitude and 79.7914° longitude in district Bageshwar, Uttarakhand, India. Three treatments were tested with fifteen replications in RBD during *Rabi* season of 2024-25. It was found that recommended dose of fertilizer (RDF) of NPK (100:60:60) along with sulphur 25 kg/ha in the form of bentolite sulphur resulted the maximum yield (99.16 q/ha), minimum post-harvest losses in terms of pooled physiological loss in weight (PLW) (21.29%) of three months storage period. Maximum net return (₹3, 80,560.0 per ha) as well as (B:C) Benefit : Cost (2.77) was recorded for T_3, followed by T_2, while the minimum net return (₹ 2, 50,400 per ha) and B: C (2.08) was estimated for T_1.

Keywords: Dose of fertilizer, Sulphur, Yield, Post-harvest losses and Economics

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Introduction

Garlic (*Allium sativum* L.) commonly known as *Lahsun* in Hindi is second most important bulb crop after onion in India. It is used as an important spice and condiment crop in India as well as in the world. Garlic is a valuable member of family Alliaceae that originated from Central Asia. The edible portion of garlic is a composite bulb formed by assemblage of small bulbous structures known as cloves. It contains 62.8% moisture, 6.3% proteins, 29% carbohydrates, 13 mg/100-1 g vitamin C, 0.03 % calcium, 0.31% phosphorous, 0.0031% iron [1]. Compact and uninjured garlic contains colourless, odourless and water-soluble amino acid "allin" that breaks down in to a sulphur containing product allium on injury or crushing. Allium present in garlic is an anti-bacterial substance of garlic and has typical odour of fresh garlic. In allium principal ingredient is odoriferous "diallyl disulphide" [2]. Garlic contains 0-1% volatile oil, whose chief constituents are diallyldisulphide (60%), allyl alcohol (5.4%), dimethyl trisulphide (2-4%), methyl allyltrisulphide (1.5%), methyl allyldisulphide (1.2%) and diallyltrisulphide (1%) [3]. Garlic has some antifungal, antimicrobial, insecticidal and other medicinal properties, so has great importance in Ayurveda and known as "Nectar of Life". Garlic has also been shown to help treat cardiovascular diseases, stomach ailments, sore eyes, and ear ache [4, 5].

India is the second largest producer of garlic after China with 10.41% share of global production during 2019-20 [6]. However, the productivity of garlic in India is about five times lower than China and Egypt [7]. Among the various factors of this low productivity, lack of proper application of nutrients that may be intervened at farmer's level was identified as one of the major causes in base line survey that need to be addressed in farmers perspective. Accordingly, KVK (ICAR-VPKAS) - Bageshwar, Kafligair, Uttarakhand, India conducted an on-farm trial (OFT) in farmer's participatory mode during *rabi* season of 2024-25 and critical observations that largely affects farmer's interest were studied in detail and are being presented underneath.

Materials and Methods

An on-farm assessment trial entitled "Influence of Recommended Fertilizer Dose and Sulphur on Yield, Post-Harvest Losses and Economics of Garlic (Allium sativum L.) under On-Farm Conditions" was conducted in village Baidibagar situated at 29.7236° latitude and 79.7914° longitude at 1055 m amsl in district Bageshwar, Uttarakhand, India. The base

line survey to identify the gaps that might be responsible for low productivity of garlic was conducted with personal interview of the individual farmers. Soil sampling and testing was also done and the initial soil status was 372.67 kg/ ha N, 16.57 kg/ha P_2O_5, 174.33kg/ ha K_2O and 16.17 kg/ ha S. The soil type was sandy loam having pH of 6.5 and the organic carbon percentage was 0.85%. Three treatments *viz*. T_1- Farmers practice (FYM) 5 t/h, T_2- Recommended NPK dose (100:60:60) + FYM 5 t / ha and T_3- T_2 + Basal application of bentonite sulphur @ 25 kg/ ha were tested with fifteen replications in randomized block design (RBD) during *Rabi* season of 2024-25.For providing the particular doses of NPK and S in respective treatments for each plot of 20 square meter, basal application of NPK mixture of 12:32:16 grade @ 400 g per plot, Potassium (14.5%) 400 g/ plot, Bentonite sulphur @ 50 g/ plot and Urea @ 165 g/ plot was done, while another dose of 165 g/ plot Urea was top dressed after 45 days of sowing. Nutrients provided in particular quantities through these fertilizers in each plot of concerned treatments may be converted to per ha as follows (Table 1 & Figure 1).

Table 1. Application of fertilizers.

Name of Fertilizer	Quantity applied per plot (20 m2)	Quantity conversion to per ha	Availability of nutrient per ha
NPK Mix of 12:32:16	400 g	200 kg	N- 24 kg, P- 64 kg, K- 32 kg
Potassium (14.5%)	400 g	200 kg	K- 29 kg
Urea	165 g + 165 g = 330 g	165 kg	N- 76 kg
Total RDF nutrient availability per ha N= 100 kg; P= 64 ~ 60 kg and K- 61~ 60 kg			
Conversion of 25 kg Bentonite sulphur comes out as 50 g Bentonite sulphur per plot of 20 m2 comes			

Figure 1. Layout, Treatment Application and Planting with Farmer's Participation.

Seed treatment for all the treatments was done with Carbendazim @ 1 g/ kg seed and regular prophylactic sprays of *Neem* oil (2 ml/Liter) at 20 days interval were also applied equally. The sowing was done in first week of October 2024 and the sowing geometry was 15 cm x 10 cm and the plot size was 5.0 m x 4.0 m (20.0 m^2). All the intercultural operations including weeding and hoeing were similar for all the plots.

Observations for average bulb weight yield and post-harvest loses in terms of Physiological Loss in Weight (PLW) % at different storage periods were recorded and analyzed statistically. For calculating the Physiological Loss in Weight (PLW) % following formula was applied [8];

$$\text{PLW (\%)} = \frac{\text{Initial weight of fruits} - \text{Weight of fruits on stipulated day}}{\text{Initial weight of fruits}} \text{ X } 100$$

For post- harvest parameter of PLW (%) recording, cured garlic bulb filled muslin bags weighed 5 kg on digital balance from each plot were kept at ambient temperature and defused light. After one month they were weighed again on digital balance. This weight was the final weight for the PLW % of first month, while became initial weight for the PLD % of next month. Likewise, the process continued for the third month. The economic analysis was also done on actual basis for all the treatments.

Results and Discussion

Data pertaining to average bulb weight (g), yield (q/ha) and physiological loss in weight on Garlic cv. Agrifound Parwati is presented in **Table 2** and showed statistically significant differences for all these parameters. It is evident from the Table 1 that the maximum average bulb weight (35.19 g) was recorded in T_3 that was followed by T_2 (32.18 g), while the minimum average bulb weight of 25.57 g was estimated under T_1. The corresponding significant differences were also found for yield. Maximum yield of 99.16 q/ha was recorded for T_3, followed by T_2 (77.00 q/ha) and T_1 (66.33 q/ha). Beneficial positive effects of integrated application of NPK nutrients in garlic were also recognized

[9]. Sulphur is a secondary macronutrient and is required for normal growth and development of plants. In case of garlic, which is cultivated and consumed for their sulphurous nature, sulphur supplementation is necessary. Sulphur increases yield in crops mainly by enhancing protein synthesis because sulphur is central element in essential amino acids; cysteine, cystine and methionine. Sulphur is also required for chlorophyll synthesis, which makes it critical for photosynthesis and therefore for optimal yield. Increase in garlic yield with application of sulphur has is in confirmatory to other workers also [10, 11]. PLW % estimation which is one of the most important post-harvest parameter that governs the self-life and gives extended marketing opportunities to the farmers was found to be influenced significantly with sulphur application (Table 1). PLW estimation at monthly interval as well as pooled data showed that minimum losses were with T_3, followed by T_2, while maximum physiological loss in weight was recorded for T_1. Proper application of NPK nutrients strengthen the cell was and integration of sulphur further improved the self-life by reducing the PLW. The improvement regarding storage qualities could be possible by synergistic association between sulphur and potassium that resulted in increased uptake of nutrients like N, P, K and S which enhanced dry matter content of garlic bulbs. The reason may be due to increased synthesis of primary sulphur compounds such as S-allyl cysteine compounds which are positively correlated with keeping quality of bulb as has also been reported by other researchers also for garlic and onion [12-14]

Table 2 Effect of RDF and Sulphur application on average bulb weight, yield and physiological loss in weight on Garlic cv. AgrifoundParwati

Treatment	Average bulb weight (g)	Yield (q/ha)	PLW % I Month	PLW % II Month	PLW % III Month	PLW % Pooled of 3 Months
T1- Farmers practice (FYM) 5 t/ha	25.57c	66.33c	11.78a	10.71a	9.93a	32.42a
T2- Recommended NPK dose (100:60:60) + FYM 5 t / ha	32.18b	77.00b	9.97b	9.01b	8.12b	27.09b
T3- T2 + Basal application of bentonite sulphur @ 25 kg/ ha	35.19a	99.16a	7.50c	7.28c	6.51c	21.29c
CD @5%	0.52	1.75	0.25	0.41	0.39	0.63

Economic analysis of effect of balanced fertilizer application on Garlic cv. Agrifound Parwati was estimated and presented in **Table 3**. It is evident from Table 1 that maximum cost of cultivation ₹ 2, 14,400.0 per ha was estimated for T_3, while it was minimum (₹ 1, 91,700 per ha) for T_1. However, increased yield and self- life of garlic under $T_2$and T_3 gave higher gross returns. Consequently, maximum net return (₹ 3, 80,560.0 per ha) as well as B: C (2.77) was recorded for T_3, followed by T_2, while the minimum net return (₹ 2, 50,400 per ha) and B:C (2.08) was estimated for T_1.

Table 3 Economic analysis of effect of balanced fertilizer application on Garlic cv. Agrifound Parwati

Treatment	Cost of Cultivation (₹/ha)	Gross Return* (₹/ ha)	Net Return (₹/ ha)	B:C
T1- Farmers practice (FYM) 5 t/h	1,91,700	3,97,980	2,06,280	2.08
T2- Recommended NPK dose (100:60:60) + FYM 5 t ha-1	2,11,600	4,62,000	2,50,400	2.18
T3- T2 + Basal application of bentonite sulphur @ 25 kg ha-1	2,14,400	5,94,960	3,80,560	2.77

* Market price of Garlic was ₹ 6,000/- per q

Conclusion

The study suggests that proper use of organic manure along with optimum application of NPK along with sulphur not only enhanced the yield but enhanced the self-life of garlic also. Thus, double benefits of increased yield compounded with enhanced self-life of garlic may be achieved with proper organic, NPK and sulphur application.

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