Research Article

# Effect of Plant Spacing and Farm Yard Manure on Quality and Economics of Rakkyo (*Allium Chinense* G. Don)

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**Abstract**

A field experiment was conducted at Vegetable Research Farm, Department of Vegetable Science, College of Horticulture and Forestry, CAU, Pasighat, Arunachal Pradesh to study the effect of plant spacing and FYM on quality and benefit cost ratio of rakkyo. Three spacings *viz.*, $S_3$: 20 cm × 10 cm, $S_2$: 15 cm × 10 cm and $S_1$: 10 cm × 10 cm and 5 levels of FYM *viz.*, $M_5$: FYM @ 30 t/ha, $M_4$: FYM @ 25 t/ha, $M_3$: FYM @ 20 t/ha, $M_2$: FYM @ 15 t/ ha and $M_1$: FYM @ 10 t/ha giving 15 treatment combination was studied. Significant effect spacing and FYM of the quality parameters was recorded. The highest benefit cost ratio was recorded in the treatment combination $S_2$ $M_4$ (15 cm × 10 cm + FYM @ 25 t/ha).

**Keywords:** Rakkyo, Spacing, FYM, TSS, Ascorbic acid, Benefit cost ratio

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## Introduction

Rakkyo (*Allium chinense* G. Don) is a member of the Alliaceace family, cultivated for nutritional and medicinal purposes. The plant is consumed raw, cooked or pickled. It is used in traditional Chinese medicine for treating mental stress, heart problem and tumors. For the treatment of diarrhoea, stenocardia, heart asthma and thoracic pain, a Chinese crude drug, "Xiebai", is prepared from dried bulbs [1, 2]. Important therapeutic properties like anti inflammatory, anti-tumour, anti-hyperlipidemic and anti-alzeihmer's disease properties have also been reported in rakkyo [3].

It is hardy plant and has a vigourous growth habit. It grows well in almost all types of soil but prefers a well drained soil and can be grown in both in temperate as well as semi-tropical areas. The plant is tolerant to drought and can be grown without irrigation but supplemental irrigation increases the yield [4]. In north eastern region of India, locally they are cultivated in small patches of land in home garden and have good market values in terms of occurrences. The bulbs of the previous season are used as the planting material.

Plant spacing and nutrients play a crucial role in the production of quality crops. Higher plant population per area can be obtained by closer spacing and vice versa. However, for proper utilization of the resources, optimum plant density is pre-requisite. Organic source of nutrients ensures in the production of not only safe and quality foods and helps in balancing the environment. Therefore, this experiment was conducted to study the effects of plant spacing and FYM on the quality and the cost economics of rakkyo.

## Materials and methods:

The field experiment was conducted during October 2019 to April 2020 at Vegetable Research Farm, Department of Vegetable Science, College of Horticulture and Forestry, Central Agricultural University, Pasighat, Arunachal Pradesh. The experimental farm is located at 28°07`N latitude and 95°32`E longitude at an altitude of 153 m above msl. A local genotype of Arunachal Pradesh was used as the planting material for the experiment. Three different spacings *viz.*, $S_3$: 20 cm × 10 cm, $S_2$: 15 cm × 10 cm and $S_1$: 10 cm × 10 cm and 5 levels of FYM *viz.*, $M_5$: FYM @ 30 t/ha, $M_4$: FYM @ 25 t/ha, $M_3$: FYM @ 20 t/ha, $M_2$: FYM @ 15 t/ ha and $M_1$: FYM @ 10 t/ha giving 15 total treatment combinations was laid out in FRBD with three replications. FYM application was done about 20 days before bulb planting and the primary nutrient composition of the FYM was 0.52 % N, 0.18 % P and 0.48 % K. Rakkyo was harvested after 173 days of planting. The TSS (°Brix) of the bulb was measured with the help of hand refractometer and ascorbic acid (mg/100g) content was determined by the method described by Ranganna [5].

$$\text{Benefit cost ratio was calculated by using the given formula} = \frac{\text{Net income (₹/ha)}}{\text{Total cost of cultivation (₹/ha)}}$$

Statistical analysis was performed using R-software (R-core team, 14) platform [6]. Mean separation was performed using the least significant difference (LSD) test with probability level of 5%.

## Results and discussions

### *Effect of spacing*

The total soluble solid (TSS) was affected significantly by spacing ($p < 0.001$) (**Table 1**). $S_1$ (10 cm × 10 cm) recorded the highest TSS with a value of 15.83 °Brix, followed by $S_2$ (15 cm × 10 cm) and the lowest was recorded in $S_3$ (20 cm × 10 cm). Lesser spacing recorded higher TSS, which is in line with the findings reported by Gunda [7] and Naruka and Dhaka [8] in garlic. It may be attributed to minimal respiration and transpiration loss in lesser spaced plants for increased TSS [7]. There was no significant effect of spacing on ascorbic acid content of bulb although some variation was recorded among the different plant densities (Table 1). The highest was recorded in $S_3$ with a value of 7.89 mg/100g.

**Table 1** Effect of spacing and FYM on TSS (°Brix) and ascorbic acid (mg/100g)

| Treatment | TSS (°Brix) | Ascorbic acid (mg/100g) |
|---|---|---|
| **Spacing (S)** | | |
| $S_3$ | $13.86^{c}$ | $7.89^{a}$ |
| $S_2$ | $14.90^{b}$ | $7.78^{ab}$ |
| $S_1$ | $15.83^{a}$ | $7.58^{b}$ |
| Significance | *** | NS |
| **FYM (M)** | | |
| $M_5$ | $15.17^{a}$ | $8.17^{a}$ |
| $M_4$ | $15.07^{ab}$ | $8.01^{ab}$ |
| $M_3$ | $14.86^{abc}$ | $7.71^{bc}$ |
| $M_2$ | $14.69^{bc}$ | $7.58^{cd}$ |
| $M_1$ | $14.51^{c}$ | $7.28^{d}$ |
| Significance | * | *** |

Values with the same letter within the column are not statistically different at $p<0.05$. *, ** and *** = Significant at 0.05, 0.01 and 0.001 probability levels, respectively. NS = Not significant

### *Effect of FYM*

Application of FYM recorded significant effect ($p < 0.05$) on the TSS (Table 1). FYM @ 30 t/ha ($M_5$) recorded maximum TSS with a value of 15.17 °Brix, however there was no statistical difference with $M_4$ (FYM @ 25 t/ha) and $M_3$ (FYM @ 20 t/ha) and minimum was observed in $M_1$ (FYM @ 10 t/ha). Higher TSS with higher levels of FYM may be attributed to supply of both macro and micro nutrients by FYM which play an important role in improving the quality during growth through desirable enzymatic changes [9]. Similar findings on effect of FYM in TSS were also reported by Bhati [10] and Kaswan [9] in onion. Application of FYM ($p < 0.001$) was significant on the ascorbic acid content; increasing trend was observed with higher dose of FYM (Table 1). The highest was recorded in $M_5$ (FYM @ 30 t/ha) however there was no significant difference with $M_4$ (FYM @ 25 t/ha). This may be attributed to optimum conditions and nutrient availability enhancing the uptake of the valuable nutrients, ultimately favoring the synthesis of chlorophyll and photosynthesis, thereby improved the ascorbic acid content [11]. Doklega [11] also reported higher ascorbic acid content with higher levels of FYM in onion.

### *Interaction effect of spacing and FYM*

There was no significant interaction between spacing and FYM on TSS as well as the ascorbic acid content in rakkyo (**Table 2**).

### *Benefit cost ratio*

The benefit cost ratio range between 2.36 to 3.38. Maximum benefit: cost ratio of 3.38 value was found in spacing of 15 cm × 10 cm and application of organic manure (FYM) @ 25t/ha ($S_2M_4$). This may be attributed to optimum yield and utilization of the resources as compared to the other treatments where there may be competition among the individual plants or wastage of spaced, moisture and nutrients or requirement of more mandays for higher density treatments along with the cost of the FYM and application.

**Table 2** Interaction effect of spacing and FYM on TSS (°Brix), ascorbic acid (mg/100g) and B:C ratio

| Treatment | TSS (°Brix) | Ascorbic acid(mg/100g) | B:C ratio |
|---|---|---|---|
| $S_3M_5$ | $14.10^{ghi}$ | $8.40^{a}$ | 2.40 |
| $S_3M_4$ | $14.10^{ghi}$ | $8.14^{ab}$ | 2.59 |
| $S_3M_3$ | $13.93^{hi}$ | $7.77^{abcd}$ | 2.42 |
| $S_3M_2$ | $13.67^{i}$ | $7.67^{bcd}$ | 2.38 |
| $S_3M_1$ | $13.50^{i}$ | $7.50^{bcde}$ | 2.36 |
| $S_2M_5$ | $15.25^{bcdef}$ | $8.05^{abc}$ | 3.04 |
| $S_2M_4$ | $15.10^{cdef}$ | $8.03^{abcd}$ | 3.38 |
| $S_2M_3$ | $14.90^{defg}$ | $7.77^{abcd}$ | 3.13 |
| $S_2M_2$ | $14.70^{efgh}$ | $7.67^{bcd}$ | 3.10 |
| $S_2M_1$ | $14.53^{fgh}$ | $7.39^{de}$ | 3.09 |
| $S_1M_5$ | $16.17^{a}$ | $8.05^{abc}$ | 2.62 |
| $S_1M_4$ | $16.00^{ab}$ | $7.87^{abcd}$ | 2.87 |
| $S_1M_3$ | $15.76^{abc}$ | $7.60^{bcde}$ | 2.72 |
| $S_1M_2$ | $15.70^{abcd}$ | $7.42^{cde}$ | 2.56 |
| $S_1M_1$ | $15.50^{abcde}$ | $6.95^{e}$ | 2.73 |
| Significance | NS | NS | NA |

Values with the same letter within the column are not statistically different at $p<0.05$. *, ** and *** = Significant at 0.05, 0.01 and 0.001 probability levels, respectively. NS = Not significant

## Conclusion

The study revealed significant effect of both spacing and FYM on the quality parameters. Taking into account both the effect of spacing and FYM on quality parameters (though higher TSS and ascorbic acid content was recorded in some other treatments, was not statistically significant) as well as the benefit cost ratio it is concluded that the treatment combination of spacing of 15 cm × 10 cm and application of FYM @ 25t/ha ($S_2M_4$) maybe considered for production of rakkyo along with repeated field trials.

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