

## Studies on Plant Density in Radish (*Raphanus sativus* Linn.)

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**Introduction:** In cultivation of tuber crops, over crowding of plants affects their growth and development resulting in mis-shapen and ill-developed tubers. Liberal sowing of seeds and subsequent thinning of plants in tuber crops assure perfect stand and also impart market appeal with better size and shape of tubers. An experiment was conducted in the Vegetable Section, Coimbatore to ascertain the optimum number of plants of radish (*Raphanus sativus* Linn.) per hill and the results are presented.

**Material and Methods:** The experiment consisted of three treatments viz., one plant, two plants and three plants per hill, replicated ten times and was conducted for three seasons. Seeds of white radish were sown spaced at 60 cm between ridges and at 20 cm along the ridge. The excess number of plants per hill were thinned 15 days after sowing to conform to the treatments. Except for thinning, all operations were similar to all the three treatments. Yields of tubers and foliage, and dimensions and weight of tubers were recorded. Foliage efficiency and root index as suggested by Banga (1950 and 1952) and root-shoot ratio were computed.

**Results and Discussion:** The data on yield and other characters have been presented in Table 1.

The more the number of plants per hill, the higher was the yield of tubers recording significant increase by 21% in three plants and 13% in two plants over single plant per hill. But the size of tubers got reduced as the number of plants per hill increased. The reduction was significant in both the length and diameter of the tubers affecting significantly the root-index and thereby the market appeal. The tuber size got down-graded from the root-index of 5.39 in single plants to 5.09 in two plants and to 4.83 in three plants per hill. The larger the number of plants per hill, the lower was the size of tubers and the root index and this is in conformity with the findings of Banga (1950). The mean weight of a tuber was 188 g in case of single plant compared to 111g in two plants and to 80 g in three plants per hill. The decrease in the weights of tubers was significant and affected the market value. As recorded by Shoe maker (1953) in carrot and by Watts and Watts (1939) in sugar beet, in the present study also, over crowding of plants affected the shape and size of tubers (plate).

According to Banga (1952), the growth rate of tubers is determined to a large extent by "foliage efficiency". In garden beet he found a close positive

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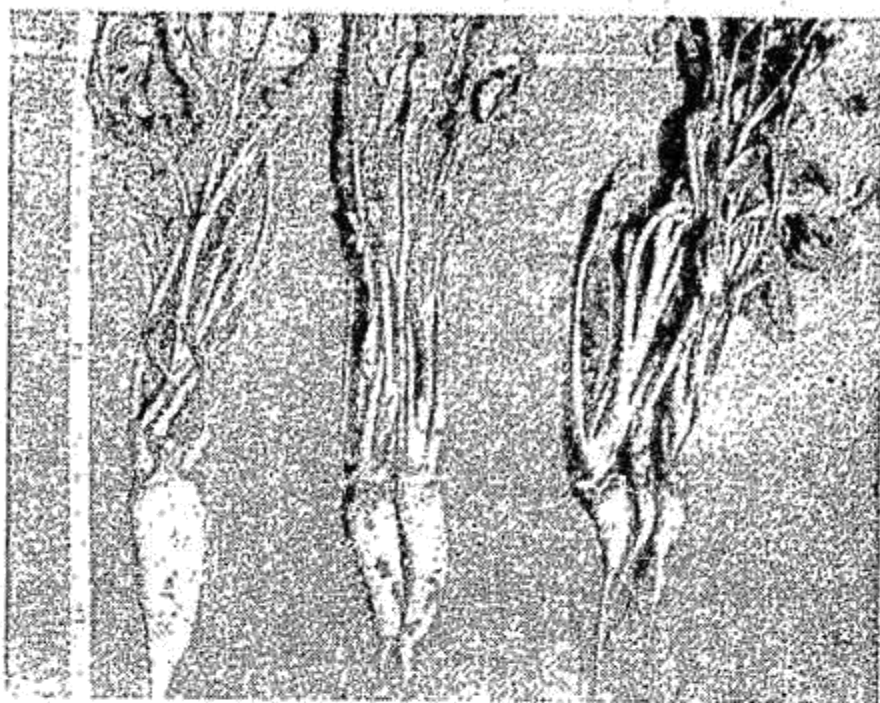


PLATE. Differentiation in tuber formation in radish when grown as one two or three plants per hill.

correlation between foliage weight and top-root ratio. In the present study also, the amount of foliage had influenced the development of tubers. When plants were raised in singles, the weight of foliage per plant was higher and the tubers were heavy, more uniform and with better size. On the contrary, with increase in the number of plants per hill, there was significant decrease in the weight of foliage per plant and corresponding reduction in the size and weight of tubers and the root-top ratio increased. Radish exhibited a positive relationship between size and weight of tubers and foliage weight and between foliage weight and top-root ratio in agreement with the finding of Banga (1952) in garden beet.

The root-top ratio was also closely associated with the size and weight of tubers. The root-top ratio was narrow with 1: 1.33 in single-plant and it widened with increase in the number of plants reaching 1: 1.75 in case of two plants and to 1: 1.96 in case of three plants per hill. The narrower the root-top ratio, the better was the size and weight of tubers.

In cultivation of tuber crops, the quantity of marketable produce realised is an important factor. Eventhough three plants per hill gave significantly higher yield than one plant per hill, the percentage of marketable tubers was only 58.34 compared to 82.13 in two plants and 98.72 in single plant per hill. This is on account of a large percentage of mis-shapen and ill-developed tubers as the number of plants per hill increased in conformity with

TABLE 1. Yield and Characteristics of tubers

Treatments	Yield of tubers		Yield of foliage (kg/ha)	Weight of tuber/plant (g)	Weight of foliage/plant (g)	Root-top ratio	Foliage efficiency (Wt. of leaf/100 g of tubers)	Length of tuber (cm) l	Diameter of tuber (cm) d	Root index l/d	Marketable tuber		Net return (Rs/ha)	Additional income (Rs/ha)
	(kg/ha)	Percentage									(kg/ha)	Percentage to total yield		
A. Single seedlings / hill	11,670	100	15,543	188	251	1:1.33	133.51	32.94	6.11	5.39	11,545	98.72	1,732	489
B. Two seedlings / hill	13,205	113	24,092	111	195	1:1.75	175.67	25.50	5.09	5.09	10,594	82.13	1,589	355
C. Three seedlings / hill	14,101	121	28,036	80	157	1:1.96	196.25	18.31	3.79	4.83	8,226	58.34	1,234	—
Whether sig. or not	Yes	Yes	Yes	Yes	Yes	—	Yes	Yes	Yes	Yes	—	—	—	—
S. E.	693.22	50.94	398.53	3.32	8.91	—	5.62	0.62	0.32	0.06	—	—	—	—
C. D.	1932.71	16.56	1020.71	9.97	25.92	—	16.11	2.02	1.02	0.21	—	—	—	—
Conclusion		<u>CBA</u>	CBA	ABC	ABC	—	CBA	ABC	ABC	ABC	—	—	—	—

the findings of Shoemaker (1953), Watts and Watts (1939), Knott (1941) and Schroter (1965).

The number of plants of radish per hill plays an important role in the development of tubers. When more than one plant is raised per hill, naturally there is competition between the plants for the available space and nutrients and the development of plants are affected resulting in less foliage per plant, spindly roots and mis-shapen and light tubers. Over crowding of plants affects the root-top ratio also. In radish single plant per hill gives uniformly heavy and better shaped tubers of high quality with better market appeal yielding more monetary return than when the plants are crowded. In the present study, single plant per hill gave an additional income of Rs. 143/ha over two plants per hill and Rs. 498/ha over three plants per hill. In radish it is therefore advisable to raise one plant per hill to derive maximum benefit.

**Summary:** An experiment was conducted to ascertain the advantages of growing one, two or three plants of radish per hill. The experiment revealed that (1) even though three plants per hill gave significantly higher yield compared to single plant populations, the development of tuber was seriously affected resulting in large percentage of mis-shapen and ill-developed tubers; (2) the larger the number of plants per hill the lower was the size of tubers and the root-index; (3) a positive relationship existed between size and weight of tubers and foliage weight, and between foliage weight and top-root ratio; (4) the narrower the top-root ratio the better was the size and weight of tubers, and (5) single plant per hill gave uniformly heavy and better shaped tubers of high quality with better market appeal, yielding more monetary return than when the plants are crowded.

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