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Influenced of organic, inorganic manures and plant density on economics of radish (*Raphanus sativus* L.)

Priynka Kumari Jat, SP Singh, Manoj Kumar Rolaniya, Sajana Devi and Ram Kisan Bairwa

Abstract
A field experiment was conducted during *rabi* season of 2014-15 on sandy loam soil to "Effect of organic, inorganic manures and plant densities on performance of radish (*Raphanus sativus* L.)". The experiment consisted three treatment of organic manures (control, VC @ 5 t/ha and FYM @ 15 t/ha), three treatment of inorganic manures (control, 50% RDF of NPK and 100% RDF of NPK) and two treatment of plant densities (20 x 10 cm and 30 x 10 cm), thereby making eighteen treatment combinations tested in randomized block design with three replications. The economics of maximum net returns (262595 /ha) was recorded with combined application of vermicompost 5 t/ha + 100% RDF of NPK + 30 x 10 cm spacing and maximum B: C ratio (3.28) was recorded with combined application of vermicompost 5 t/ha + 50% RDF of NPK + 30 x 10 cm spacing. Radish was significantly superior to other treatments in including sole or combination in different proportions.

Keywords: FYM, Growth, NPK, Plant density, Radish, RDF, Vermicompost and Economic

Introduction
Radish (*Raphanus sativus* L.) is one of the most popular root crop of *rabi* season and is widely acclaimed for its excellent nutritive and medicinal values. It belongs to family Cruciferae and it has (2n=18) chromosomes. It is popular in both tropical and temperate countries. The radish leaves are rich in minerals and vitamin A (5 IU) and vitamin C (15 mg) and are roots rich in potassium (138 mg) and calcium (50 mg). The edible part of radish is modified root which develops form both primary root and hypocotyls. The pungency in radish is due to the presence of volatile isothiocynates. FYM being rich in organic matter is required for supplementing the nutrients provided through other manure. The organic manure not only provides nutrients to plants but also improves the soil texture by binding effect to soil aggregates. Organic manure increases CEC, water holding capacity and phosphate availability of the soil, besides improving the fertilizer use efficiency and microbial population of soil; it reduces nitrogen loss due to slow release of nutrients. Vermicompost is a slow releasing & organic manure which have most of the macro as well as micro nutrients in chelated form and fulfill the nutrients requirement of plant for longer period. Vermicompost helps in reducing C:N ratio, increasing humic acid content, cation exchange capacity and water soluble carbohydrates [6].

The balanced fertilization in radish is important factor to boost yield attributes. Availability of nitrogen is important for growing plant as it is major indispensable constituent of protein and nucleic acid. An adequate supply of nitrogen is associated with vigorous vegetative growth and more efficient use of available inputs, finally leading to higher productivity.

Phosphorus is transfer of energy within the plant system and is involved in its various metabolic activities; Phosphorus has its beneficial effect on early root development, plant growth, yield and quality [1]. Phosphorus plays a key role in the formation of energy bound phosphate (ADP and ATP).

Potassium imparts vigour and disease resistance to the plant and plays an important role in crop productivity. There are evidences of direct involvement of potassium in photosynthesis and its involvement in leaf tissues metabolic activities of chloroplast. It regulates transpiration through opening and closing of the stomata by affecting activities of guard cells.

Optimum plant population is also another important aspect of crop production; wider plant spacing not only leads to excessive vegetative growth but also accelerates the evaporative losses of water from the bare ground. On the other hand, the struggle for existence increases with increasing plant population because of severe competition for light, water and nutrients [5].

Materials and Methods

A field experiment was conducted during *rabi* season of 2014-15 at Department of Horticulture, College of Agriculture, Jobner, in a randomized block design with three replications (Fisher R. A. 1950). The soil was loamy sand in texture, alkaline in reaction (pH 8.1), low in organic carbon (0.16%), low available nitrogen (130 kg/ha), medium available phosphorus (15.1 kg P2O5/ ha) and medium in potassium (140 kg K2O/ha) content. The experiment consisted three treatment of organic manures (control, VC @ 5 t/ha and FYM @ 15 t/ha), three treatment of inorganic manures (control, 50% RDF of NPK and 100% RDF of NPK) and two treatment of plant densities (20 x 10 cm and 30 x 10 cm), thereby, making eighteen treatment combinations. Fertilizers were applied as per treatment through Urea, SSP and MOP at the time of sowing as basal dose and split application of urea at top dressing. The radish cv. 'Pusa Rashmi' was sown on 8th September 2014 using seed rate of 10 kg/ha with a row spacing of 20x10 cm and 30x10 cm. The 6-10 days interval irrigations were applied during growing season. Intercultural operations *viz.*, thinning, hoeing and weeding were followed after 20 days of sowing to maintain recommended spacing and weed control. Two hand weeding during growing period and harvest maturing in 50 to 55 days after sowing and observations on tagged plants were recorded.

Economics

1. Gross Income (Rs) = Total crop production x Value of the product (both main and by product)
2. Total cost = Common cost + Treatment cost
3. Net return (Rs/ha) Net return (Rs/ha) of individual treatment was calculated by deduction of cost of cultivation from the gross return of particular treatm

Net return = Gross Return – Total Cost of Cultivation.

Table 1: General cost of cultivation (Rs ha^{-1}) (Excluding the cost of the treatment inputs)

S. No.	Particulars	Unit	Rate per unit (Rs)	Cost/ha (Rs)
I.	Variables			
(A)	Labour charges			
1.	Seed sowing	6 man days	160/man days	960
2.	Weeding	12 man days	160/man days	1760
3.	Layout of experiment	11 man days	160/man days	1760
4.	Application of manures and fertilizers	23 man days	160/man days	3680
5.	Gap filling	9 man days	160/man days	1440
6.	Irrigation labour	23 man days	160/man days	3680
7.	Cost of top dressing of urea	6 man days	160/man days	960
8.	Weeding and hoeing	40 man days	160/man days	6400
9.	Spraying of insecticides	15 man days	160/man days	2400
10.	Harvesting and selling of roots	70 man days	160/man days	11200
11.	Miscellaneous	-	-	912
	Sub total			35152
(B)	Services charges of land preparation	By tractor for 10.0 Hrs	150/hr	1500
(C)	Cost of material inputs			
1.	Seed	10 kg	1200	12000
2.	Fungicides for seed treatments	-	-	98
3.	Irrigation cost (11 irrigation in terms of electricity)	9 irrigation	600/irrigation	5400
4.	Chloropyriphos	6 lit	350	2100
5.	Malathion	2 lit	275	550
	Sub total			20148
II.	Fixed costs			
1.	Rental value of land			2500
2.	Interest on working			500
3.	Depreciation cost			600
	Sub total			3600
	Total		45	60400

General cost of cultivation = I A +I B+I C + II (35152+1500+20148+3600)
General cost of cultivation = 60400

Table 2: Economics of different treatments of radish cultivation

Treatments	Common cost (Rsha^{-1})	Treatments cost (Rs ha^{-1})	Total cost (Rs ha^{-1})	Yield (q ha^{-1})	Gross return (Rs ha^{-1})	Net returns (Rs ha^{-1})	B: C ratio
$M_0F_0S_1$	60400	7920	68320	127.77	166097	97777	1.43
$M_0F_0S_2$	60400	12000	72400	144.18	187439	115039	1.59
$M_0F_1S_1$	60400	10745	71145.2	167.29	217475	146330	2.06
$M_0F_1S_2$	60400	14825	75225.2	188.78	245419	170194	2.26
$M_0F_2S_1$	60400	13570	73970.3	174.23	226495	152525	2.06
$M_0F_2S_2$	60400	17650	78050.3	196.61	255598	177548	2.27
$M_1F_0S_1$	60400	22920	83320	177.78	231111	147791	1.77
$M_1F_0S_2$	60400	27000	87400	200.62	260808	173408	1.98
$M_1F_1S_1$	60400	25745	86145.2	232.77	302600	216454	2.51
$M_1F_1S_2$	60400	19325	79725.2	262.68	341482	261757	3.28
$M_1F_2S_1$	60400	28570	88970.3	242.42	315151	226180	2.54
$M_1F_2S_2$	60400	32650	93050.3	273.57	355645	262595	2.82
$M_2F_0S_1$	60400	12420	72820	165.29	214875	142055	1.95
$M_2F_0S_2$	60400	16500	76900	186.53	242485	165585	2.15
$M_2F_1S_1$	60400	15245	75645.2	216.42	281341	205696	2.72
$M_2F_1S_2$	60400	19325	79725.2	244.22	317492	237767	2.98
$M_2F_2S_1$	60400	18070	78470.3	225.39	293010	214540	2.73
$M_2F_2S_2$	60400	22150	82550.3	254.35	330660	248110	3.01

Radish sold @ Rs. 13/kg

Benefit: Cost ratio

In order to find out net benefit: cost ratio, the net return from individual treatments was divided by their respective cost of cultivation, which included cost of treatment also. B:C Ratio = Net return/ Total Cost of Cultivation In order to evaluate the effect of different treatments on vegetative growth and yield characters, the data were statistically analyzed as per [3].

Net Returns

Interactive effect between organic, inorganic manures and different plant spacing ware found to be significant with respect to net returns (Table 2). The maximum net returns (Rs 262595 /ha) was recorded with combined application of vermicompost 5 t/ha + 100% RDF of NPK + 30 x 10 cm spacing. This treatment was significantly superior over other treatment combinations except vermicompost 5 t/ha + 50% RDF of NPK + 30 x 10 cm spacing (261757 /ha) which was found at par. Maximum net return realization of Rs 171862 in cabbage at plant spacing of 30X30 cm had also been reported by [4].

B: C Ratio

Interactive effect between organic, inorganic manures and different plant spacing had significant effect on B: C ratio (Table 2.). The maximum B: C ratio (3.28) was recorded with combined application of vermicompost 5 t/ha + 50% RDF of NPK + 30 x 10 cm spacing. This treatment was significantly higher over other treatment combinations. However, application of 20 x 10 cm with control gave minimum B: C ratio (1.43). On the basis of the experiment as well as economic point of views, an application of organic manures in combination with inorganic manures produced its significant impact on net returns and cost of benefits ratio. The treatments ($M_1F_1S_2$) were found economical, profitable and proved highly remunerative under the Jobner (Rajasthan, India) conditions for growing the Radish cv. 'Pusa Rashmi', which also improved the soil health.

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