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Efficacy of bio-fertilizer, organic and inorganic fertilizer on yield and quality of radish (*Raphanus sativus* L.)

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Abstract
An experiment entitled 'Performance of organic manures, inorganic fertilizer and biofertilizer of yield and quality of radish' was conducted during *Rabi* season of 2016-17 at the field site of AICRP on Vegetable Crops of O.U.A.T. The experiment was laid out in Randomized Block Design with three replications. In all eight treatments were imposed. The result of present investigation indicated that the yield plot^{-1} as well as hectare^{-1} and the NPK content in leaves and roots of radish were found highest in treatment with either safe production (Recommended FYM @ 20t ha^{-1} + fertilizer @ 80:60:80 NPK kg ha^{-1} + PP with organic methods) + IIHR microbial consortium @ 12.5 kg ha^{-1}or conventional practices (Conventional practices (Recommended FYM @ 20 tha^{-1} + fertilizer @ 80:60:80 NPK kg ha^{-1} +PP chemicals+ IIHR microbial consortium @ 12.5 kg ha^{-1}) with application of 296.28 q ha^{-1}.

Keywords: Radish, FYM, vermicompost, arka microbial consortium, quality, NPK content, yield

Introduction
Among the root vegetables, radish (*Raphanus sativus* L.) is a popular Brassicaceae vegetable in both tropical and temperate region. It can be cultivated extensively in almost all seasons of the year. Pusa chetki is a cultivated variety, suitable on account of it's versatile adaptability throughout the year and also suitable to tropical condition. For an early and good crop stand, sandy to sandy loam soils are considered suitable for it. It has cooling effect, prevents constipation, increases appetite and its roots and leaves are very tasty when cooked together.
In modern agricultural practices chemical fertilizers are used on a large scale by the farmers for increasing the yield of crops. The continuous use of chemical fertilizers, oftenly in excess over a long period of time in arable land has led to contamination of food material, environmental pollution and depletion of soil fertility (Singh, 1999) [9]. The concept of integrated farming by the appropriate use of organic and inorganic fertilizers as sources of nutrients may be helpful to increase soil fertility and improvement of crops quality and growth (Semwal *et al*. 2007) [8]. A site specific integrated nutrient management after sustainable productivity, availability and supply of plant nutrients in balance proportion in the soil, a key factor in the practical way for high productivity (Prasad, 1999) [7].
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.
Recently emphasis has been given on integrated nutrient management vegetable production which can be used as a part of global strategy to ensure food security and protect the environment, minimize cost of production, increases quality of product, maintains fertility of Soil. The present investigation has been planned to study the "Efficacy of biofertilizers, organic and inorganic fertilizers on yield and quality of radish".

Materials and Methods
An experiment was conducted at the field site of All India Coordinated Research Project on Vegetable Crops of Orissa University of Agriculture & Technology, Odisha, India during *Rabi* season of 2016-17. The soil of experimental site was uniform in texture and was leveled. The investigation was laid out in Randomized Block Design with eight treatments and three replications with a plot size of 3.0 X 2.7 m^2. The details of treatments are given below:

S. No	Symbols	Treatment details
1.	T_1	Conventional practices (Recommended FYM + fertilizer@80:60:80 kg ha^{-1}+PP chemicals)
2.	T_2	Vermicompost @ 12.5 t ha^{-1} (PP with organic methods)
3.	T_3	FYM @ 20 t ha^{-1} (PP with organic methods)
4.	T_4	Conventional practices (Recommended FYM + fertilizer@80:60:80kg ha^{-1} + PP chemicals) + IIHR microbial consortium @ 12.5 kg ha^{-1}
5.	T_5	Vermicompost @ 12.5t ha^{-1} + IIHR microbial consortium @ 12.5 kg ha^{-1} (PP with organic methods)
6.	T_6	FYM @ 20t ha^{-1} +IIHR microbial consortium @ 12.5 kg ha^{-1} (PP with organic methods)
7.	T_7	Safe production (Recommended FYM + fertilizer@80:60:80kg ha^{-1} + PP with organic methods) + IIHR microbial consortium @ 12.5 kg ha^{-1}
8.	T_8	*Azospirillium* + PSB @ 4kg ha^{-1} (Control)

The good quality bold seed of radish variety Pusa Chetki was obtained from local market. The seeds were dibbled on16 august, 2016, at a distance of 30 x 20 cm. The layout is of ridges and furrows type. 15 days before sowing of seed the various nutrient were applied. Irrigation, thinning, gap filling, weeding, earthing and plant protection measures were followed timely. The observations were recorded on post-harvest quality like N, P, K content in roots and leaves. The observations related to yield were recorded as yield per plot and per hectare. For the determination of per cent of N, P and K in leaves and root, firstly the leaves and roots were kept for sun drying then kept in hot air oven at 60^0C. The fully dried leaves and roots were grinded through the grinder and by applying the following methods, the per cent of N, P and K was calculated.

Methods utilized for plant nutrient analysis

S. No.	Nutrient	Methods adopted
1	Nitrogen	Kjeldhal digestion (K_2SO_4 + $CASO_4$) + salicylic Acid + sodiumthiosulphate) and distillation (Jackson *et al.* 1973)
2	Phosphorus	Digestion with di acid (HNO_3: $HCLO_4$: 3: 2) followed by spectrophotometric determination (Jackson, 1973)
3	Potassium	Di acid digestion followed by Flame phothometric determination after digestion with di acid (Jackson, 1973)

Results and Discussion

The results obtained from the present investigation are summarized below

NPK content in leaves and roots of radish

Data presented in Table 1, indicate that the content of N, P and K in leaves and roots was maximum in Conventional practices (Recommended FYM + fertilizer@80:60:80kg ha^{-1} + PP chemicals) +IIHR microbial consortium @ 12.5 kg ha^{-1} (T_4). However, the minimum content was recorded in treatment *Azospirillium* + PSB @ 4kg ha^{-1}(Control) (T_8). The results obtained are in agreement with the findings of Bodkhe *et al*. (2010) [2] in radish, Shafeek *et al*. (2003) [5] in radish and also similar to findings of Rau and Malewar (1995).

Table 1: Effect of various treatments on nitrogen, phosphorus and potassium

Treatments		Nitrogen concentration (%) of		Phosphorus concentration (%) of		Potassium concentration (%) of	
		Radish roots	Radish shoots	Radish roots	Radish shoots	Radish roots	Radish shoots
T_1	Conventional practices (Recommended FYM @ 20 t ha^{-1} + fertilizer @ 80:60:80 NPK kg ha^{-1} +PP chemicals)	4.10	2.90	0.40	0.280	4.20	3.95
T_2	Vermicompost @ 12.5tha^{-1} (PP with organic methods)	4.16	2.89	0.38	0.272	4.18	3.95
T_3	FYM @ 20 t ha^{-1} (PP with organic methods)	4.12	2.88	0.35	0.275	4.17	3.76
T_4	Conventional practices (Recommended FYM @ 20 t ha^{-1} + fertilizer @ 80:60:80 NPK kg ha^{-1} + PP chemicals) + IIHR microbial consortium @ 12.5 kg ha^{-1}	4.18	2.92	0.44	0.282	4.25	3.93
T_5	Vermicompost @ 12.5tha^{-1} + IIHR microbial consortium @ 12.5 kg ha^{-1} (PP with organic methods)	4.15	2.90	0.40	0.270	4.17	3.96
T_6	FYM @ 20tha^{-1} +IIHR microbial consortium @ 12.5 kg ha^{-1} (PP with organic methods)	4.14	2.87	0.37	0.278	4.16	3.85
T_7	Safe production (Recommended FYM @ 20t ha^{-1} + fertilizer @ 80:60:80 NPK kg ha^{-1} +PP chemicals) + IIHR microbial consortium @ 12.5 kg ha^{-1}	4.17	2.89	0.44	0.280	4.24	3.90
T_8	*Azospirillium* + PSB (Control)	4.01	2.83	0.30	0.260	3.98	3.52
	Mean	4.13	2.89	0.38	0.275	4.17	3.85
	SE (m) ±	0.01	0.02	0.02	0.003	0.01	0.01
	CD (5%)	0.03	0.04	0.05	0.007	0.03	0.02
	CV	0.36	0.86	7.64	1.434	0.40	0.25

Yield per plot and yield per hectare

Data presented in Table 2, in concerned to yield per plot, revealed that maximum yield per plot and yield per hectare was recorded in Safe production (Recommended FYM @ 20t ha^{-1} + fertilizer @ 80:60:80 NPK kg ha^{-1} +PP chemicals) + IIHR microbial consortium @ 12.5 kg ha^{-1} (T_7) which was statiscally at par with treatment T_4 i.e, Conventional practices (Recommended FYM @ 20 t ha^{-1} + fertilizer @ 80:60:80 NPK kg ha^{-1} +PP chemicals)+IIHR microbial consortium @ 12.5 kg ha^{-1}. However, the minimum yield was recorded in treatment *Azospirillium* + PSB (Control) (T_8). The increased yield per plot in integrated application of organic manures

(FYM) along with RDF with or without Arka microbial consortium had significantly influence on root yield attributing parameters. Integrated application of inorganic fertilizer + FYM had positive increased in growth of the plants, in turn the yield attributing parameters. This might be due to faster in cell division, multiplication and cell elongation in meristematic region of the plant due to production of plant growth substances by FYM, may be due to more healthy growth, which ultimately leads to maximum yields. These results are in agreement with the findings of Shrivastava (1998) [6], Buckerfield *et al*. (1999) in radish and Sood and Lal (2004) in potato.

Table 2: Effect of various treatments on yield per plot and yield per hectare of radish

Treatments		Yield plot^{-1} (kg)			Yield (qha^{-1})		
		Radish roots	Radish shoots	Total radish yield	Radish roots	Radish shoots	Total radish yield
T_1	Conventional practices (Recommended FYM @ 20 t ha^{-1} + fertilizer @ 80:60:80 NPK kg ha^{-1} +PP chemicals)	20.95	24.50	45.45	258.62	302.45	561.07
T_2	Vermicompost @ 12.5tha^{-1} (PP with organic methods)	14.78	9.00	23.78	182.45	111.10	293.55
T_3	FYM @ 20 t ha^{-1} (PP with organic methods)	17.17	13.60	30.77	211.96	167.89	379.85
T_4	Conventional practices (Recommended FYM @ 20 t ha^{-1} + fertilizer @ 80:60:80 NPK kg ha^{-1} +PP chemicals) + IIHR microbial consortium @ 12.5 kg ha^{-1}	23.55	25.10	48.65	290.72	309.85	600.57
T_5	Vermicompost @ 12.5tha^{-1} + IIHR microbial consortium @ 12.5 kg ha^{-1} (PP with organic methods)	13.75	8.85	22.60	169.74	109.26	279.00
T_6	FYM @ 20tha^{-1} + IIHR microbial consortium @ 12.5 kg ha^{-1} (PP with organic methods)	10.90	12.42	23.32	134.56	153.33	287.90
T_7	Safe production (Recommended FYM @ 20t ha^{-1} + fertilizer @ 80:60:80 NPK kg ha^{-1} +PP chemicals) + IIHR microbial consortium @ 12.5 kg ha^{-1}	24.00	25.37	49.37	296.28	313.19	609.47
T_8	*Azospirillium* + PSB (Control)	6.82	6.69	13.51	84.16	82.63	166.79
	Mean	16.49	15.69	32.18	203.56	193.71	397.27
	SE (m) ±	1.56	1.25	2.18	19.23	15.44	26.80
	CD (5%)	3.34	2.67	4.69	41.25	33.13	57.48
	CV	11.56	9.73	8.31	11.57	9.76	8.26

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