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Impact of organic and inorganic sources of nutrients on growth, yield and quality of onion (*Allium cepa* L.) in southern Rajasthan

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Abstract

A field experiment was conducted to find out the effect of organic manures with or without PSB and Azotobactor on yield, quality and economics of onion (Agri found dark red) on a clay loam soil. The treatments comprised of organic, inorganic fertilizer and biofertilizers with ten treatments *i.e*. 100% RDF through inorganic, 100% RDF through FYM (N Basis), 100% RDF through vermicompost,50% RDF through Inorganic Fertilizers + 50% through FYM, 50% RDF through Inorganic Fertilizers + 50% through vermicompost, 5 0% RDF through Inorganic Fertilizers + 50% through FYM + PSB, 50% RDF through Inorganic Fertilizers + 50% through vermicompost + PSB, 50% RDF through Inorganic Fertilizers + 25% vermicompost + PSB, 100% RDF through FYM (N Basis) + PSB + *Azotobactor* and 100% RDF through vermicompost + PSB + *Azotobactor*. Growth parameters like plant height (cm), number of leaves, fresh weight of leaves (g plant^{-1}) and dry weight of leaves (g plant^{-1}) were significantly influenced with 100% RDF through Vermicompost + PSB + *Azotobactor* at 30 and 60 days of transplanting. The diameter of bulb (cm), bulb weight (g), bulb yield (q ha^{-1}), total soluble solid (^{0}B) and allyl propyl content (ppm) significantly increased with 100% RDF through Vermicompost + PSB + *Azotobactor*). Similarly, Application of 100% RDF applied through vermicompost + PSB + *Azotobactor* (T_{10}) recorded maximum gross returns, net return and cost benefit ratio of onion crop.

Keywords: Bulb yield, allyl propyl, onion, FYM, vermicompost

Introduction

Onion (*Allium cepa* L.) is one of the most important commercial vegetable crops grown extensively throughout the country. It is a bulbous biennial herb of the most important vegetable cum condiments, spice crops demanded worldwide. India is the second largest producer of onion in the world, next to China, with 70% of the total production comes as winter crop and remaining 30% as *kharif* onion as off season crop, accounting for 11.40 per cent of the area and 10.40 per cent of the world production and 16 per cent of productivity. In India, onion is being grown in an area of 3.64 million hectares with production of 68.45 million tonnes and the average productivity is 18.82 tonnes per hectare. Maharashtra is the leading onion growing state of India (Anonymous, 2013) [1]. Organic manures not only provide plant nutrient but also improve the soil structure by effecting soil aggregates. They also decrease EC and increase water holding capacity and phosphate availability of soils, besides improving the fertilizer use efficiency and microbial activity. Bio fertilizers play a key role in increasing the availability of nutrient. Inoculation of these bio-fertilizers in very small quantity supplemented with sufficient amount o organic matter converts the insoluble and unavailable from of nutrient in soluble and available from of nutrients. The organic manures contain nutrients in small quantities as compared to the chemical fertilizers, also it contain growth promoting substances like enzymes and hormones, besides improvement of soil fertility and productivity (Bhuma, 2001) [2]. Organic materials such as poultry manure, green manures and farmyard manure (FYM) can substitute for inorganic fertilizers to maintain productivity and environmental quality (Choudhary *et al*., 2002) [3]. The bio-fertilizers are alternative sources to meet the nutrient requirement of crops and to bridge the future gaps. Further, knowing the deleterious effect of using only chemical fertilizers on soil health, use of chemical fertilizers supplemented with organic waste and bio-fertilizers will be environmentally benign.

Materials and Methods

The experiment was conducted at the farmer's field, village-Suwana, near Krishi Vigyan Kendra, Bhilwara, Maharana Pratap University of Agriculture & Technology, Udaipur, Rajasthan, India *Rabi* season to find out effect of coinjoint use of organic and inorganic sources of nutrients on growth, yield and quality of onion (*Allum cepa* L.) var. Agrifound Dark Red. The soil of the experimental field was clay loam in texture and having pH 7.85, EC 0.11 dSm^{-1}, organic carbon content 0.42%, low in available N (178 kg/ha), medium P (18.7 kg/ha) and high in K (348 kg/ha). The experiment was laid out in randomized block design with three replications. The treatments comprised of organic, inorganic fertilizer and biofertilizers with ten treatments T_1 -100% RDF through inorganic, T_2 -100% RDF through FYM (N Basis), T_3 -100% RDF through vermicompost, T_4 -50% RDF through Inorganic Fertilizers + 50% through FYM, T_5 -50% RDF through Inorganic Fertilizers + 50% through vermicompost, T_6 -50% RDF through Inorganic Fertilizers + 50% through FYM + PSB, T_7 -50% RDF through Inorganic Fertilizers + 50% through vermicompost + PSB, T_8 -50% RDF through Inorganic Fertilizers + 25% vermicompost + PSB, T_9 -100% RDF through FYM (N Basis) + PSB + *Azotobacter* and T_{10} - 100% RDF through vermicompost + PSB + *Azotobacter*.

The treatments of manure, chemical fertilizers and bio-fertilizers were applied as per treatment in respective plot. Vermicompost and FYM were applied prior to 15 days of transplanting of Onion. PSB and *Azotobacter* bio-fertilizer was applied at the time of transplanting. Inorganic fertilizer *i.e.* SSP and Murate of Potash were applied as a basal dose during transplanting whereas as 1/2 dose of urea was applied at the time of transplanting and remaining 1/4 – 1/4 dose applied at 30 and 60 days of transplanting respectively. The seeds of onion variety “Agrifound Dark Red” were treated with bavistin + carbandazim (SAAF) @ 3 gm kg^{-1} before sowing in nursery. The seed of onion variety Agrifound Dark Red was raised in the nursery of 3 m long and 1.2 m wide and 10 cm above the ground level was prepared and manured as per the recommendation treatments. Treated seed were sown on 22 December 2016 in line and all the intercultural operations were done as and when required. 57 days old seedlings of uniform size were transplanted on 17 December 2017 in the prepared field. The spacing 15 cm row to row and 10 cm plant to plant was maintained. The seedlings were transplanted in cool evening according to the layout plan. A light irrigation was applied just after the transplanting and subsequent irrigation was given at an interval of 10-12 days depending upon the soil condition. Harvesting of onion was done on 31^{st} May 2017.

The data on plant height (cm), number of leaves plant $^{-1}$, fresh weight of leaves, dry weight of leaves parameters were recorded at 30 and 60 DAT, whereas diameter of bulb (cm), average bulb weight (g), bulb yield (q ha^{-1}), total soluble solid (^{0}B) at harvest, Allyl Propyl content (ppm) and economics parameters were recorded and thereafter, tabulated and analyzed statistically by method of analysis of variance. The data were analyzed statistically and result were interpreted by using methods suggested by Panse and Sukhatme (1967) [7].

Results and Discussion

Growth parameters

The vegetative parameters like plant height (cm), number of leaves plant $^{-1}$, fresh weight of leaves, dry weight of leaves parameters were recorded at 30 and 60 DAT, were greatly influenced by both organic and inorganic nutrient sources. The plant height increased significantly with the different treatments of organic manures, inorganic fertilizers and bio-fertilizer up to harvesting (Table 1). This may be due to application of nutrient management through vermicompost along with bio-fertilizers, increased the photosynthetic activity, chlorophyll formation, nitrogen metabolism and auxin contents in the plants which ultimately improving the plant height. These findings were in agreement with the findings of Prabhakar *et al.* (2012) [8]. The significantly maximum leaves per plant was recorded in the treatments T_{10} (100% RDF through Vermicompost + PSB + *Azotobactor*) at 30 and 60 days of transplanting followed by T_9 (100% RDF through FYM + PSB + *Azotobactor*). However, the minimum leaves per plant was recorded under treatment T_2 (100% RDF through FYM) at 30 and 60 DAT. Probable reasons for enhanced more number of leaves may be due to promotive effects of integrated nutrient management on vegetative growth which ultimately lead to more photosynthetic activities. These findings was in agreement with the findings of Jawadagi *et al.* (2012) [5]. The fresh weight of leaves was significantly influenced by various treatments of organic manures, inorganic fertilizers and bio-fertilizer. Similar results reported by Mahanthesh *et al.* (2005) [6]. Similarly, significantly maximum dry weight of leaves was exhibited in the treatment T_{10} (100% RDF through Vermicompost + PSB + *Azotobactor*), followed by T_7 (50% RDF through Inorganic Fertilizers + 50% through Vermicompost + PSB). However, the minimum dry weight of leaves was observed in T_2 (100% RDF through FYM). This may be due to application of major and micro nutrients by organic manure which increased the photosynthetic activity, chlorophyll formation, nitrogen metabolism and auxin contents in the plants which ultimately improving the dry weight of leaves.

Post-harvest parameter of crop

Diameter of bulb increased significantly with different treatments of organic manures, inorganic fertilizers and biofertilizer (Table 2). This may be due to application of organic manures which provide major and micro nutrients resulted in increased the photosynthetic activity, chlorophyll formation, nitrogen metabolism and auxin contents in the plants which ultimately improving the diameter of bulb.

Significantly maximum bulb weight of bulb was exhibited in the treatment T_{10} (100% RDF through Vermicompost + PSB + *Azotobactor*) followed by T_9 (100% RDF through FYM + PSB + *Azotobactor*), Bulb yield per hectare differed significantly due to application of 100% RDF through Vermicompost + PSB + *Azotobactor* significantly increased the bulb yield of onion. The higher yield might be due to increase in plant height, number of leaves, and other yield attributes *viz*., fresh weight of whole plant, fresh and dry weight of bulb. Similar results have been reported by Shinde *et al.* (2013) [10] and Gurjar *et al.* (2017) [4].

The maximum TSS (12.04%) was recorded with T10 followed by 11.35% TSS in T_9 (Table 2). The superior quality of onion under vermicompost treatments might be due to beneficial effect of organism which are brought about mucon deposited epidermal cell and coelomic cell of earthworm containing plant growth factor and B group vitamin. The effect of organic manure on quality parameters was also reported by Singh *et al.* (2015) [4]. The allyl propyl content (ppm) of onion influenced by different organic and inorganic treatments. Significantly maximum allyl propyl content was observed under the treatment T_{10} (100% RDF applied through vermicompost + PSB + *Azotobactor*) and found significantly superior over rest of the treatment followed by T_9 where 100% RDF applied through FYM + PSB + *Azotobacter*. Whereas the minimum allyl propyl content at harvest was recorded in T_1 (100% RDF through inorganic fertilizer).

Table 1: Effect of different organic and inorganic sources and their combinations on growth parameters of onion.

Treatment	Plant height		Number of leaves		Fresh weight of leaves (g/plant)		Dry weight of leaves (g/plant)	
	30 DAT	60 DAT	30 DAT	60 DAT	30 DAT	60 DAT	30 DAT	60 DAT
T_1 - 100% RDF through Inorganic Fertilizers	21.33	38.67	5.00	8.20	22.67	40.80	3.27	5.37
T_2 - 100% RDF through FYM (N basis)	17.40	36.67	4.80	7.84	21.67	39.00	3.20	5.00
T_3 - 100% RDF through Vermicompost (N basis)	19.77	37.77	5.09	8.29	26.00	46.80	3.83	5.97
T_4 - 50% RDF through Inorganic Fertilizers + 50% through FYM	20.07	38.07	5.60	8.80	25.67	47.80	3.75	6.00
T_5 - 50% RDF through Inorganic Fertilizers + 50% through Vermicompost	19.27	37.27	5.53	8.73	29.67	53.40	4.40	6.67
T_6 - 50% RDF through Inorganic Fertilizers + 50% through FYM + PSB	22.83	43.00	5.97	9.20	28.00	47.60	4.10	5.97
T_7 - 50% RDF through Inorganic Fertilizers + 50% through Vermicompost + PSB	25.47	45.13	5.87	9.13	29.67	53.40	4.45	6.62
T_8 - 50% RDF through Inorganic Fertilizers + 25% Vermicompost + 25% FYM + PSB	24.07	42.07	5.27	10.32	29.17	52.50	4.20	6.69
T_9 - 100% RDF through FYM + PSB + *Azotobacter*	25.00	46.33	6.20	11.34	29.50	52.30	4.32	6.83
T_{10} - 100% RDF through Vermicompost + PSB + *Azotobacter*	28.67	52.00	6.93	12.63	34.33	60.53	5.05	7.69
S.Em±	0.93	1.17	0.13	0.23	1.57	2.42	0.24	0.39
C.D. (5%)	2.77	3.47	0.38	0.67	4.66	7.20	0.72	1.15

Table 2: Effect of different organic and inorganic sources and their combinations on yield and quality parameters of onion.

Treatment	Diameter of bulb (cm)	Average weight of bulb (g)	Bulb yield (Q/ha)	Total soluble solids (ºB)	Allyl propyl content (ppm)
T_1 - 100% RDF through Inorganic Fertilizers	5.78	81.00	137.70	9.27	17.00
T_2 - 100% RDF through FYM (N basis)	5.98	85.17	144.78	8.67	17.17
T_3 - 100% RDF through Vermicompost (N basis)	6.37	93.69	159.28	9.71	18.13
T_4 - 50% RDF through Inorganic Fertilizers + 50% through FYM	6.64	94.53	160.71	10.05	18.69
T_5 - 50% RDF through Inorganic Fertilizers + 50% through Vermicompost	7.03	104.00	176.80	10.37	19.23
T_6 - 50% RDF through Inorganic Fertilizers + 50% through FYM + PSB	7.33	109.00	185.30	10.76	19.50
T_7 - 50% RDF through Inorganic Fertilizers + 50% through Vermicompost + PSB	7.36	113.00	192.10	10.95	20.23
T_8 - 50% RDF through Inorganic Fertilizers + 25% Vermicompost + 25% FYM + PSB	7.20	117.17	199.18	11.11	20.80
T_9 - 100% RDF through FYM + PSB + *Azotobacter*	7.75	120.00	204.00	11.35	21.80
T_{10} - 100% RDF through Vermicompost + PSB + *Azotobacter*	8.77	129.08	219.44	12.04	22.73
S.Em±	0.32	1.27	2.16	0.09	0.31
C.D. (5%)	0.96	3.77	6.40	0.26	0.92

Table 3: Effect of different organic and inorganic sources and their combinations on economics of onion.

Treatment	Bulb yield (q ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	BC ratio
T_1 - 100% RDF through Inorganic Fertilizers	137.70	57674	96390	38716	1.67
T_2 - 100% RDF through FYM (N basis)	144.78	67700	101346	33646	1.50
T_3 - 100% RDF through Vermicompost (N basis)	159.28	62699	111496	48797	1.78
T_4 - 50% RDF through Inorganic Fertilizers + 50% through FYM	160.71	62687	112497	49810	1.79
T_5 - 50% RDF through Inorganic Fertilizers + 50% through Vermicompost	176.80	65200	123760	58560	1.90
T_6 - 50% RDF through Inorganic Fertilizers + 50% through FYM + PSB	185.30	62887	129710	66823	2.06
T_7 - 50% RDF through Inorganic Fertilizers + 50% through Vermicompost + PSB	192.10	65400	134470	69070	2.06
T_8 - 50% RDF through Inorganic Fertilizers + 25% Vermicompost + 25% FYM + PSB	199.18	61637	139426	77789	2.26
T_9 - 100% RDF through FYM + PSB + *Azotobacter*	204.00	68150	142800	74650	2.10
T_{10} - 100% RDF through Vermicompost + PSB + *Azotobacter*	219.44	65149	153608	88459	2.36

Economics

The cost of cultivation, gross returns, net returns and benefit cost ratio as influenced by different treatments are presented in Table 3. Application of 100% RDF applied through vermicompost + PSB + *Azotobacter* (T_{10}) recorded maximum gross returns of Rs. 153608 ha^{-1} followed by treatment having 100% RDF applied through FYM + PSB + *Azotobacter* (T_9), whereas minimum gross return (Rs 96390 ha^{-1}) was recorded in treatment T_1 (100% RDF through inorganic fertilizers). Data also revealed that the highest net return of Rs 88459 ha^{-1} was obtained in treatment T_{10} (100% RDF applied through vermicompost + PSB + *Azotobacter)* along with cost benefit ratio 2.36. While, lowest net return (Rs 33646 ha^{-1}) along with lowest cost benefit ratio 1.50 was observed in treatment T_2 (100% RDF through FYM). Similar results have been reported by Gurjar *et al.* (2017) [4].

Conclusion

The results of present investigation revealed plant height (cm), number of leaves, fresh weight of leaves (g $plant^{-1}$) and dry weight of leaves (g $plant^{-1}$) were significantly influenced with 100% RDF through Vermicompost + PSB + *Azotobacter* at 30 and 60 days of transplanting. The diameter of bulb (cm), bulb weight (g), bulb yield (q ha^{-1}), total soluble solid (^{0}B) and allyl propyl content (ppm) significantly increased with 100% RDF through Vermicompost + PSB + *Azotobacter*). Application of 100% RDF applied through vermicompost + PSB + *Azotobacter* (T_{10}) recorded maximum gross returns, net return and cost benefit ratio.

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