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Effect of integrated nutrient management on growth and yield of *rabi* onion and its residual effect on succeeding okra crop

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ABSTRACT

The field experiment was conducted to access the effect of inorganic fertilizers, organic manures and bio-fertilizers on growth and yield of *rabi* onion (*Allium cepa* L.) and its residual effect on succeeding crop okra. The experiment comprised of 36 treatment combinations and replicated three times, was laid out in split-plot design with three fertility levels (0, 75 and 100% of recommended dose of NPKS) and three treatments of organic manures (control, FYM @ 20 t ha^{-1} and poultry manure @ 5 t ha^{-1}) were applied in main plots. Four bio-fertilizers (No inoculation, PSB inoculation, *Azospirillum* inoculation and PSB + *Azospirillum* inoculation) were applied in sub plots. The two year results of the study have clearly showed that application of inorganic fertilizers up to 75% RDF significantly increased all the growth parameters (plant height, number of leaves and chlorophyll content in leaves), yield and yield attributes (bulb diameter, yield of onion and okra). Similarly, application of poultry manure @ 5 t ha^{-1} significantly increased all the growth parameters, yield and yield attributes of onion. The maximum values for growth parameters, yield and yield attributes achieved on combined inoculation with PSB + *Azospirillum*. Application of 75 recommended doses of NPKS along with poultry manure @ 5 t ha^{-1} is better for realizing better bulb diameter and yield of onion. Further it may be concluded that application of 75% RDF of NPKS + 5 t ha^{-1} poultry manure is worth recommendable for farmers to get significantly better yield, net returns and maximum B:C ratio from onion and its succeeding crop okra by utilizing residual effect of treatment.

Key words: *Allium cepa*, *Abelmoschus esculentus*, PSB, *Azospirillum*, inorganic fertilizers, bio-fertilizers.

INTRODUCTION

Onion (*Allium cepa* L.) is a biennial or perennial herb belongs to family Alliaceae. It is one of the most important cash vegetable crop among bulb crops and semi-perishable in nature. It can be transported to a long distance without much transit injury losses. The significance of crop further enhances due to its multiple uses. Onion is rich in protein, calcium, phosphorus and carbohydrates. India is second largest producer of onion after china in the world, cultivating onion over an area of 1320 thousand hectare with total production of 20931 thousand metric tonnes (Anonymous, 1). In Rajasthan, it is grown over an area of 86.31 thousand hectare with a production of 1435.11 thousand metric tonnes (Anonymous, 1). The application of different doses of nitrogen increases plant growth and yield of onion. Similarly, phosphorus has its beneficial effect on early root development, plant growth, yield and quality of crop produce. Potassium plays important role in crop productivity by functioning as an activator of numerous enzymes like pyruvic kinase, cytoplasmic enzymes and therefore, cause pervasive effect on metabolic events. The application of different doses of sulphur improves plant height, number of leaves, bulb diameter, bulb weight and yield of onion (Kumar *et al*., 7). The application of organic manures like FYM and poultry manure alone and in combination with NPK have been reported to decrease the bulk density, improve the soil porosity and increase water holding capacity of soil (Yadav, 14). Further, inoculation of biofertilizers mobilizes nutrient elements from unavailable to available form through biological processes. These are biologically active strains or products containing active form of microorganisms. Phosphate Solubilizing Bacteria (PSB) when inoculated, secrete anti-biotic substances and solubilise the otherwise unavailable insoluble soil phosphorus and then make it available to the plant. The inoculation of PSB bio-fertilizer increases the yield of crops by 10 to 30 per cent. *Azospirillum* inoculation helps the plants to attain better vegetative growth and also in saving inputs of nitrogenous fertilizers by 20-30%. Application of *Azospirillum* had significant effect on nutrient uptake, which may be helpful for increasing the crop production by way of enhancing the soil fertility. Use of biofertilizers not only supplement the nutrients but also improve the efficiency of applied nutrients (Bhati *et al.*, 3). Studies have also shown that integrated use of

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chemical fertilizers, organic residues like FYM, compost etc. and biofertilizers resulted in reduced losses of nutrients and environmental pollution. There is meager information on the balanced use of chemical fertilizers along with FYM, poultry manure and biofertilizers for onion crop grown in Rajasthan under semi arid zone IIIA. In last few years, a greater concern regarding use of biofertilizers and organic sources as alternative/supplements to chemical fertilization has been derived to reduce the high cost that inorganic fertilizers represent in agricultural production.

MATERIALS AND METHODS

The present investigation was carried out at the Horticulture farm, S.K.N. College of Agriculture, Jobner during *rabi* season for two years (2014 and 2015), to find out the influence of inorganic fertilizer organic manure and bio-fertilizers on growth parameters, yield and yield attributes of onion. Geographically, Jobner is situated at 26^0 05' North latitude and 75^0 20' East longitude and an altitude of 427 meters above mean sea level, in Jaipur district of Rajasthan. This region falls under agro-climatic zone IIIA (Semi-Arid Eastern Plain) of the state. The average rainfall of the locality is approximately 400 to 500 mm; most of which is received in rainy season from July to September. Yearly pan evaporation ranges from 1.3-17.5 mm per day. The soil of the experimental field was loamy sand having 131.7 kg ha^{-1} available nitrogen, 14.8 kg ha^{-1} available phosphorous, 149.0 kg ha^{-1} available potassium and 9.88 kg ha^{-1} available sulphur. The study was carried out with application three fertility levels (0, 75 and 100% of recommended dose of NPKS) through urea, SSP, MOP and elemental sulphur and three treatments of organic manures (control, FYM @ 20 t ha^{-1} and poultry manure @ 5 t ha^{-1}) were applied in main plots. Four treatments of bio-fertilizers (No inoculation, PSB inoculation, *Azospirillum* inoculation and PSB + *Azospirillum* inoculation) were applied in sub plots. Experiment was performed in split plot design with three replications. The onion (RO-252) seedling was transplanted at 20 cm row to row and 10 cm plant to plant spacing using 10 kg seed ha^{-1}. The recommended dose of NPKS for onion crop is 100:50:100:60 kg ha^{-1}. After harvest of onion crop, the field was prepared with the help of spade after giving pre-sowing irrigation without disturbing the plots. The beds were prepared at the original place of each plot. Okra was sown at 40 cm × 30 cm spacing. The seed of Arka Anamika @ 18 kg ha^{-1} were sown in well prepared plots. Healthy crops of onion and okra were raised following standard agronomic practices. The observations on growth parameters and yield and yield attributes were recorded with respect to influence of inorganic fertilizers, organic manures and bio-fertilizers and their interaction effects. The data were statistically analyzed as per the method suggested by Panse and Sukhatme (9).

RESULTS AND DISCUSSION

Application of 100% RDF recorded the maximum mean plant height (50.56 cm), number of leaves per plant (9.54), chlorophyll content in leaves (0.0736 mg g^{-1}) and it registered 36.42, 38.66 and 15 per cent increase in plant height over control (Table 1). However, it was found statistically at par with F_1 (75% RDF). The result of present study clearly indicate that plant height, number of leaves per plant, chlorophyll content in leaves increased significantly upto application of 75% RDF (Table 1). Application of increasing levels of fertility may be attributed to better nutritional environment in the root zone as well as in the plant system. It is well established that nitrogen is the most indispensable of all mineral nutrients for growth and development of the plant as it is the basis of fundamental constituents of all living matter. Similar to nitrogen, phosphorus is also a nutrient that plants need in relatively large quantities for normal plant growth. Plants derive their internal energy from P-containing compounds, mainly adenosine diphosphate (ADP) and adenosine triphosphate (ATP). This means that inadequate P supply will result in a decreased synthesis of RNA, the protein maker leading to depressed growth. Phosphorus deficient plants, therefore, are stunted with a limited root system and thin stem (Patel and Patel, 10). The response to potassium fertilization in terms of overall improvement in growth parameters is further supported by the fact that the leaching losses of potassium were more in light textured soils (Yawalkar *et al.,* 15). Therefore, potassium fertilization improved overall crop growth in terms of plant height, number of leaves per plant and chlorophyll content in leaves. Sulphur is an essential constituent of certain amino acids namely cysteine, methionin involved in synthesis of protein and sulphur bearing vitamins like biotin, thiamine and some co-enzyme. It is also a constituent of "Allyl propyl disulphide" which imparts the pungency in onion.

The data reveals that application of poultry manure @ 5 t ha^{-1} and FYM @ 20 t ha^{-1} significantly increased the plant height, number of leaves and chlorophyll content in leaves of onion to the extent of (39 & 36), (56 & 53) and (20 & 14) per cent over no organic manure application, being statistically at par with each other (Table 1). The positive influences in growth parameters are associated with the release of macro and micro nutrients

Table 1. Effect of inorganic fertilizers, organic manures and bio-fertilizers on growth, yield & yield attributes and economics of onion and its residual effect on yield of succeeding crop okra and economics of onion including residual crop okra (pooled).

Treatments	Plant height (cm)	Number of leaves	Chlorophyll (mg g^{-1})	Equatorial diameter of bulb (cm)	Polar diameter of bulb (cm)	Bulb yield (q ha^{-1})	Net returns (Rs. ha^{-1})	B:C ratio	okra yield (q ha^{-1})	Net returns (Rs. ha^{-1})	B:C ratio
Inorganic fertilizers											
0% RD of NPKS	37.06	6.88	0.0640	3.81	3.37	186.10	100649	3.07	69.54	201967	3.33
F_1 (7 75% RD of NPKS	49.47	9.32	0.0713	5.72	5.05	300.18	186143	4.42	99.78	347930	4.77
100% RD of NPKS	50.56	9.54	0.0736	5.87	5.19	305.00	188070	4.34	102.06	354416	4.76
SEm±	0.42	0.10	0.0009	0.06	0.05	3.12	2540	0.03	0.90	2663	0.04
CD (P=0.05)	1.19	0.30	0.0026	0.18	0.15	8.96	7296	0.09	2.57	7649	0.10
Organic manures											
Control	36.53	6.28	0.0623	3.53	3.23	199.17	110114	3.21	66.79	205915	3.35
FYM @ 20 t ha^{-1}	49.77	9.62	0.0715	5.74	5.07	287.03	174403	4.12	101.08	338793	4.62
Poultry Manure @ 5 t ha^{-1}	50.79	9.84	0.0751	6.12	5.32	305.08	190346	4.50	103.51	359604	4.90
SEm±	0.42	0.10	0.0009	0.06	0.05	3.12	2540	0.03	0.90	2663	0.04
CD (P=0.05)	1.19	0.30	0.0026	0.18	0.15	8.96	7296	0.09	2.57	7649	0.10
Bio-fertilizers											
No-inoculation	36.71	7.60	0.0655	4.70	3.74	202.05	109039	3.03	82.30	235869	3.58
PSB inoculation	47.10	8.59	0.0690	5.14	4.68	277.47	169255	4.15	90.66	312805	4.41
Azospirillum inoculation	48.52	8.84	0.0705	5.24	4.73	279.81	171127	4.18	91.14	315637	4.45
PSB + *Azospirillum* inoculation	50.46	9.30	0.0735	5.46	5.01	295.71	183727	4.41	97.74	341437	4.72
SEm±	0.52	0.12	0.0009	0.07	0.06	3.51	2375	0.04	0.95	3264	0.04
CD (P=0.05)	1.44	0.35	0.0026	0.18	0.17	9.81	6637	0.10	2.65	9123	0.12

during the course of microbial decomposition. The improvement in plant height, number of leaves with application of organic manures might be due to better moisture holding capacity and availability of major and micro nutrients due to favorable soil conditions. The interactive influence of mineral nutrients and FYM on growth might be due to improved physico-chemical and biological properties like water holding capacity, hydraulic conductivity, high rate of microbial transformations which make availability of organic carbon in the form of FYM for heterotrophic organisms. It might act as stimulant for supply of crop nutrients during the course of decomposition. Poultry manure besides supplying major nutrients (1.20% N, 2.15% P_2O_5 and 1.20% K_2O) also possessed secondary elements like Ca, Mg and S. Poultry manure also contains uric acid having 60 per cent nitrogen, which changes rapidly to ammonical form and hence efficiently utilized for better plant growth. In the chemical properties, poultry manure lowers down the soil pH. This is achieved through the liberation of CO_2 and organic acid during decomposition and its decomposition products may give rise natural complexing agents that solubilize the nutrients already present in soil and available to the plant. Results of Meena *et al.* (2015) also revealed that there was higher release of nutrients from added organic sources.

Combined application of PSB and *Azospirillum* represented the significantly maximum 37, 22 and 12 percent increase in plant height, number of leaves and chlorophyll content in leaves over control. The significantly maximum plant height, number of leaves and chlorophyll content in leaves were recorded by the combined use of PSB + *Azospirillum* inoculation and minimum in no inoculation (Table 1). Application of *Azospirillum* improves nitrogen status of the soil because it is free nitrogen fixers. Efficient and healthy strain of *Azospirillum* in rhizosphere, which in turn have resulted in greater fixation of atmospheric nitrogen and consequently use by the plant resulting in vigorous growth of it. Similar results have been reported by Jayathilake *et al.* (5). PSB when inoculated, secrete anti-biotic substances and solubilise the otherwise unavailable insoluble soil phosphorus and then make it available to the plant. The inoculation of PSB bio-fertilizer increases the yield of crops by 10 to 30 per cent. Results of present investigation showing that use of these bio-fertilizers significantly improved growth parameters. However, the improvement in these characters were found limited when these bio-fertilizers were used singly, but the additive effect noticed when PSB and *Azospirillum* were used together. Such an additive influence of bio-fertilizers may attributable to mutually beneficial role played by each of the two groups of bio-fertilizers used.

The application of NPKS @ 100% RDF had significantly higher mean equatorial diameter of bulb, polar diameter of bulb, bulb yield and yield of residual okra crop by 54, 54, 63, and 46 per cent over control (Table 1). The result of present study clearly indicate that equatorial and polar diameter, bulb yield and yield of residual okra crop increased significantly due to application of 100% RDF (Table 1 and 4). However, these yield attributes showed non significant differences between application of 75% RDF and 100% RDF. The increase in these parameter due to nitrogen application may be explained on the basis that nitrogen fed to plants might have made their rapid growth and acquired healthy green colour due to increased synthesis of chlorophyll content which in turn resulted in enhanced net assimilation rate due to increased photosynthetic activities. Thus, it also resulted in thickening of scales. Moreover, the nitrogen application might have influenced the availability of other nutrients also especially phosphorus and sulphur and thus better nutrition, ultimately leading to increased yield attributes. The bulb yield, being a function primarily of the cumulative effect of yield attributing parameters, increased significantly with the application of nitrogen fertilization upto 75% RDF. The observed significant increase in bulb yield of onion with increase in application of N might be due to low initial available N status (131.70 kg ha^{-1}) of the experimental soil. The plant adequately supplied with N had more number of functional leaves and photosynthesizing area which consequently contributed to better growth and development of individual plant (Biswas *et al*., 4). This inturn resulted in production of more yield.

The beneficial influence of phosphorus in early stage of growth may be explained by early stimulation of scanty root system through efficient translocation to the roots of certain growth stimulating compounds formed on account of protoplasmic activity of tops in phosphorus fed plants, which enhanced absorption of nitrogen and other nutrients and their utilization. The increase in yield attributes and yield may also be due to functional role of potassium resulting in higher net photosynthetic activity and denser rooting system. The application of sulphur in experiment through various treatments helped to cure deficiency of low initial available sulphur in experimental soil appropriate dose of sulphur might have used for better development and thickening of xylem and collenchyma fibers because of higher rate of protein synthesis and enhanced photosynthetic activity of the plant with increased chlorophyll synthesis (Biswas *et al*., 4). Further, sulphur being an integral constituent of

certain amino acids of which nitrogen is also essential constituent, might have helped in increasing net assimilation rate of nitrogen and other nutrients. Thus, it might have resulted in increased yield attributes.

Application of poultry manure @ 5 t ha^{-1} and FYM @ 20 t ha^{-1} increased the equatorial and polar diameter, bulb yield and yield of residual crop okra to the extent of (73 & 62), (64 & 56), (53 & 44) and (54 & 51) per cent in pooled analysis, respectively over control (Table 1). Data presented in table 1 revealed that the equatorial and polar diameter, bulb yield and yield of residual crop okra increased significantly with the application of poultry manure @ 5 t ha^{-1}. However, it was statistically at par to FYM @ 20 t ha^{-1} only in number of scales and yield of residual crop. Poultry manure and FYM having a material which contains better levels of nutrients and water holding capacity and release macro and micro nutrients during the course of microbial decomposition. Organic matter is also a source of energy for soil micro flora which brings the transformation of soil inorganic nutrients in the form that is readily utilized by growing plant and improved the physical properties of the soil (Singh and Singh, 12). The beneficial response of Poultry manure and FYM to yield might also be attributed to the availability of sufficient amount of plant nutrients throughout the growth period of crop resulting, plant vigour and yield. The increased yield and yield attributes with poultry manure might be because of rapid availability and utilization of nitrogen for various internal plant processes for carbohydrates production. Later on these carbohydrates may undergo hydrolysis and get converted into reproductive sugars which ultimately helped in increasing yield. The carbohydrates content due to application of poultry manure might be attributed to balanced C: N ratio and increased activity of plant metabolisms. These results are also in close conformity with the findings of Meena *et al.* (8).

Combined use of PSB + *Azospirillum* increased the equatorial and polar diameter, bulb yield and yield of residual crop okra to the extent of 16, 36, 46 and 18 per cent, respectively over control (Table 1). The result of present study (Table 1) clearly indicate that equatorial and polar diameter, bulb yield and yield of residual crop okra increased significantly due to combined inoculation of PSB + *Azospirillum*. The reason is due to the fact that *Azospirillum* is known to produce antifungal, antibiotic substances that inhibit varieties of soil borne fungal diseases. It can also synthesize the thiamin, riboflavin, pyridoxin, cyanocobalamine, nicotinic, acid, pentathenic acid, indole acetic acid and gibberellins or gibberellins like substances resulting in vigorous plant growth and dry matter production which in turn resulted in better fertilization, bulb development and ultimately the higher yield. Further, *Azospirillum* inoculation might have helped in increasing nitrogen availability because it is a micro acrophillic nitrogen fixer. It colonizes the root mass, fixes nitrogen in loose association with plants and these bacteria induce the plant root to secrete mucilage which create low oxygen involvement and help to fix atmospheric nitrogen which reflected in the better yield attributes. Increased activity of plant growth substances like gibberellic acid, indole acetic acid and dihydrozeatin in *Azospirillum* inoculated plant, might have improved the yield. The solubilization effect of PSB is generally due to the production of organic acids by this organism. They are also known to produce amino acids, vitamins, growth promoting substance like indole acetic acid and gibberellic acid which help in better growth of crop and ultimately yield attributes and yields. Biological nitrogen fixation depends appreciably on the available form of phosphorus. So the combined inoculation of nitrogen fixer and PSB may benefit the plant better (by proving both nitrogen as well as phosphorus) than either group of organism alone. Such mutually beneficial synergistic effects have also been reported by Yadav *et al.* (13) and Meena *et al.* (8).

Interaction effect of different levels of fertility and organic manures were found significant for diameter (equatorial and polar), bulb yield and yield of residual crop okra and net returns. Maximum diameter (equatorial and polar), bulb yield, residual crop okra yield and net returns (Table 2 and 3) were obtained with 100% RDF combined with poultry manure @ 5 t ha^{-1}. However, this combination was recorded statistically at par with 75% RDF + poultry manure @ 5 t ha^{-1} while in case of yield of residual crop okra 100% RDF combined with FYM @ 20 t ha^{-1} was also reported statistically at par to it. Maximum B: C ratio (Table 3) was obtained with combined use of 75% RDF and poultry manure @ 5 t ha^{-1}. The use of poultry manure in the absence of chemical fertilizer has remarkable effect in improving the diameter (equatorial and polar), fresh weight of bulb, bulb yield, yield of residual crop okra and net returns. However, it was decreased with increasing levels of fertilizers. It is also apparent that a saving of 25% nutrients in use of fertilizer could be made by applying poultry manure alongwith chemical fertilizers. Besides improving soil physical properties, poultry manure is a good source of major and micro plant nutrients. The beneficial response of poultry manure to yield might also be attributed to the better availability of plant nutrients throughout the growth period (Singh and Mishra, 11). The incorporation of organic manure in soil and its successive decomposition enabled the onion and its succeeding crop okra plant to ensure on almost continuous supply of nutrients

Table 2. Interactive effects of inorganic fertilizers and organic manures on yield & yield attributes of onion and yield of succeeding crop okra (Pooled).

Treatments	Control	FYM @ 20 t ha^{-1}	Poultry Manure @ 5 t ha^{-1}	Mean
	Equatorial diameter of bulb (cm)			
0% RD of NPKS	2.62	4.27	4.55	**3.81**
75% RD of NPKS	3.93	6.40	6.82	**5.72**
100% RD of NPKS	4.04	6.57	7.00	**5.87**
Mean	3.53	5.74	6.12	
SEm±	0.11			
CD (P=0.05)	0.31			
	Polar diameter of bulb (cm)			
0% RD of NPKS	2.40	3.76	3.95	**3.37**
75% RD of NPKS	3.59	5.64	5.92	**5.05**
100% RD of NPKS	3.69	5.80	6.08	**5.19**
Mean	3.23	5.07	5.32	
SEm±	0.09			
CD (P=0.05)	0.27			
	Bulb yield (q ha^{-1})			
0% RD of NPKS	140.46	202.54	215.30	**186.10**
75% RD of NPKS	226.67	326.67	347.21	300.18
100% RD of NPKS	230.37	331.88	352.74	**305.00**
Mean	199.17	287.03	305.08	
SEm±	5.41			
CD (P=0.05)	15.52			
	Okra yield (q ha^{-1})			
0% RD of NPKS	51.30	77.71	79.62	**69.54**
75% RD of NPKS	73.69	111.49	114.16	**99.78**
100% RD of NPKS	75.37	114.04	116.77	**102.06**
Mean	**66.79**	**101.08**	**103.51**	
SEm±	**1.55**			
CD (P=0.05)	4.46			

Table 3. Interactive effects of inorganic fertilizers and organic manures on economics of onion and onion including residual crop okra (Pooled).

Treatments	Control	FYM @ 20 t ha^{-1}	Poultry Manure @ 5 t ha^{-1}	Mean
	Net returns (Rs. ha^{-1})			
0% RD of NPKS	67640	111300	123007	**100649**
75% RD of NPKS	130831	204830	222768	**186143**
100% RD of NPKS	131870	207079	225261	**188070**
Mean	110114	174403	190346	
SEm±	4400			
CD (P=0.05)	12636			
	B:C ratio			
0% RD of NPKS	2.51	3.19	3.50	**3.07**
75% RD of NPKS	3.59	4.62	5.05	4.42
100% RD of NPKS	3.51	4.54	4.96	**4.34**
Mean	3.21	4.12	4.50	
SEm±	0.06			
CD (P=0.05)	0.16			
	Net returns (Rs. ha^{-1})			
0% RD of NPKS	132473	228955	244472	**201967**
75% RD of NPKS	240431	390041	413317	**347930**
100% RD of NPKS	244842	397384	421023	**354416**
Mean	**205915**	**338793**	**359604**	
SEm±	**4613**			
CD (P=0.05)	13249			
	B:C ratio			
0% RD of NPKS	2.61	3.59	3.81	3.33
75% RD of NPKS	3.72	5.14	5.46	**4.77**
100% RD of NPKS	3.71	5.13	5.45	**4.76**
Mean	**3.35**	**4.62**	**4.90**	
SEm±	**0.06**			
CD (P=0.05)	0.18			

efficiently synchronizing with crop requirements. The considerable mineralization of NPKS as a consequence of organic manure application may be attributed to any of the following reasons. The organic acids and CO_2 (formed during the decomposition of organic matter of the soil as well as added organic materials) has solubilization effect on iron, aluminium, magnesium and calcium phosphate. The NPKS contained in the organic matter of the soil or the one added from outside is liberated upon decomposition. Organic anions and hydroxy ions, such as tartaric, citric, melanic and malic acids liberated during decomposition of organic matter or organic manures may complex or chelate iron, aluminium and prevent them from reacting with NPK ions specially phosphate ions or prevent reversion to unavailable forms. Similar results were reported by Bagali *et al.* (2) and Kumar *et al.* (6).

The highest monetary net returns from the onion crop (Rs. 225261 ha^{-1}) and including residual crop okra (Rs. 421023 ha^{-1}) were obtained under 100% RDF + poultry manure @ 5 t ha^{-1} followed by 75% RDF + poultry manure @ 5 t ha^{-1} which fetched the net returns of Rs. 222768 ha^{-1} and Rs. 413317 ha^{-1},

respectively. The corresponding B: C ratio of onion crop and onion including residual crop okra obtained with these treatments were 4.96:1, 5.45:1 and 5.05, 5.46:1, respectively (Table 3). The higher values of net returns under these treatments could be ascribed to the higher bulb yield of onion obtained under these treatments. Similar results have been reported by Meena *et al.* (8).

On the basis of results emerging out from the present investigation, it may be concluded that application of 75% RDF of NPKS + 5 t ha^{-1} poultry manure is worth recommendable for farmers to get significantly better yield, net returns and maximum B:C ratio from onion and its succeeding crop okra by utilizing residual effect of treatment.

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REFERENCES

1. Anonymous, 2017. *Horticultural Statistics at a Glance*. Horticulture Statistics Division, Dept. of Agriculture, Cooperation and Farmer's Welfare, GoI.

2. Bagali, A.N., Patil, H.B., Chimmad, V.P., Patil, P.L. and Patil, R.V. 2012. Effect of inorganics and organics on growth and yield of onion (*Allium cepa* L.). *Karnataka J. Agric. Sci.* **25**: 112-15.

3. Bhati, V., Yadav, P.K., and Kumar, R., 2018. Effect of Levels of Inorganic Fertilizers, Organic Manure and Bio- Fertilizers on Plant Growth Attributes of Onion (*Allium cepa* L.) cv. N-53 under Hot Arid Region of Western Rajasthan, India. *International J. Curr. Micro. Appl. Sci.* **7**: 3593-601.

4. Biswas, D.R., Ali, S.A. and Khera, M.S. 1995. Response of gobhi sarson (*Brassica napus* L., ISN-706) to N and S. *J. Indian Soc. Soil Sci.* **43**: 220-23.

5. Jayathilake, P.K.S., Reddy, I.P, Shrihari, D., Neeraja, G. and Reddy, K.R. 2002. Effect of nutrient management on growth, yield and yield attributes of *rabi* onion (*Allium cepa* L.). *Veg. Sci.* **29**: 184-85.

6. Kumar, A., Singh, B., Kumar, D., Kumar, P., Kumar, T., Kumar, S. and Goswami, A. 2014. Effect of balanced fertilizer and planting techniques on growth and yield of garlic (*Allium Sativum* L.). *Ann. Hort.* **7**: 123-28.

7. Kumar, S., Garhwal, O.P., and Sharma, A., 2017. Effect of Integrated Nutrient Management (INM) on Growth and Yield Attributes of *Kharif* Onion (*Allium cepa* L.). *Int. J. Pure & Appl. Biosci.* **5**: 854-57.

8. Meena, A.K., Paliwal, R., Meena, K.K. and Singh, S.P. 2015. Effect of organic manures and bio-fertilisers on yield attributes and economics of *kharif* onion (*Allium cepa* L.) in semi-arid region. *Indian Res. J. Genet. Biotech.* **7**: 259-61.

9. Panse, V.G. and Sukhatme, P.V. 1985. Statistical methods for agricultural workers. Fourth Enlarged Edition, ICAR publication, New Delhi.

10. Patel, J.J. and Patel, A.T. 1990. Effect of nitrogen and phosphorus levels on growth and yield of onion (*Allium cepa* L.) cultivar Pusa Red. *Gujarat Agric. Uni. J.* **15**: 1-5.

11. Singh, H. and Mishra, B. 1986. Kinetics of pyrite oxidation in relation to solubilizaion of rock phosphate in neutral soil. *J. Indian Soc. Soil Sci.* **34**: 52-55.

12. Singh, V. and Singh, R.M. 1974. Changes in physico-chemical properties of soil as affected by organic manures. *J. Agric. Sci. Res*., **16**: 22-27.

13. Yadav, D.K., Paliwal, R. and Yadav, B.L. 2008. Effect of inorganic, organic fertilizers and bio-fertilizers on yield and yield attributes of *rabi* onion (*Allium cepa* L.). *Haryana J. Hort. Sci.* **37**: 128-29.

14. Yadav, N. 2015. Physico-chemical Soil Quality Indicators as Influenced by Different Soil Management Practices in Central India. *Int. J. Sci. Res. Recent Sci.* **1**: 30-40.

15. Yawalkar, K.S., Agarwal, J.P. and Bokde, S. 2008. Manures and fertilizers, Tenth Revised Edition. Agri-Horticultural Publishing House, Nagpur, India.

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