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Effect of integrated nutrient management on yield parameters and yield of *rabi* onion (*Allium cepa* L.)

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Abstract

The field experiment was conducted to study the "Effect of integrated nutrient management on yield parameters and yield of *rabi* onion (*Allium cepa* L.)" in loamy sandy soils of the Horticulture farm, S.K.N. College of Agriculture, Jobner during *rabi* season of 2013-14 and 2014-15. The experiment comprising of 36 treatment combinations was replicated three times, was laid out in split-plot design having 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 used sub treatments viz. (No inoculation, PSB inoculation, *Azospirillum* inoculation and PSB + *Azospirillum* inoculation) were applied in sub plots. The results of the study envisage showed that application of inorganic fertilizers up to 75% RDF significantly increased yield parameters and yield (neck thickness, number of scales per bulb, fresh weight of bulb and yield of onion). Similarly, application of poultry manure @ 5 t ha^{-1} significantly increased yield parameters and yield of onion. Application of bio-fertilizers (PSB and *Azospirillum*) alone or in combination significantly influenced yield parameters and yield of onion. Significant maximum values for yield was parameters and yield achieved through combined inoculation with PSB + *Azospirillum*. Application of 75% recommended doses of NPKS along with poultry manure @ 5 t ha^{-1} was better for realizing enhanced fresh weight of bulb and bulb yield of onion.

Key words: onion, inorganic nutrients, organic manures, bio-fertilizers and yield.

Introduction

Onion (*Allium cepa* L.) is a biennial or perennial herb and belongs to the family Alliaceae. It is one of the most important cash crop vegetable, among the bulb crops and is 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 (Bose *et al.*, 1989). The application of different doses of nitrogen increased plant growth and yield of onion (Sharma, 1992). Similarly, phosphorus has its beneficial effect on early root development, plant growth, yield and quality of crop produce (Balai, 2002). Potassium plays an 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 (Jana *et al.*, 1990). 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 (Maheswarappa *et al.*, 1999). Further, inoculation biofertilizers mobilize 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 (Tilak and Annapurna, *1993*). *Azospirillum* inoculation helps the plants to attain better vegetative growth and also in saving inputs of nitrogenous fertilizers by 20-30 per cent. 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 (Subbian, 1994). Use of biofertilizers not only supplement the nutrients but also improve the efficiency of applied nutrients (Somani *et al.*, 1990). Studies have also showed that integrated use of chemical fertilizers, organic residues like FYM, compost etc. and biofertilizers resulted in reduced losses of nutrients and environmental pollution (Ange, 1993).

Materials and Methods

The present investigation was carried out at the Horticulture farm, S.K.N. College of Agriculture, Jobner during *rabi* season of 2013-14 and 2014-15, to findout the influence of inorganic fertilizer, organic manure and bio-fertilizers on yield parameters and yield of onion. The soil of the experimental site 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 at 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 inculcation, PSB inculcation, *Azospirillum* inculcation and PSB + *Azospirillum* inoculation) were applied in sub plots. Experiment was laid out in split plot design, the plot size measuring 2.0m x 1.5m (3 m), having three replications. The onion seedling was transplanted at 20 cm row to row and 10 cm plant to plant spacing using 10 kg seed per hectare. Healthy crop of onion was raised following standard agronomic practices. Observations on yield parameters and yield of onion were recorded periodically 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 (1985).

Results and Discussion

Effect of inorganic fertilizers

The result of present study clearly indicate that neck thickness, number of scales per bulb, fresh weight of bulb and bulb yield (Table-1) increased significantly on application of 100% RDF. However, application of 75% RDF and 100% RDF failed to show any significant differences. 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 lead to thickening of scales. Moreover, the nitrogen application might have influenced the availability of other nutrients including phosphorus and sulphur and thus better nutrition, ultimately leading to increased yield parameters. 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 increased 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*., 1995). This in turn resulted in production of more yield. These results are in conformity to the reports of Singh (2000). 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 parameters and yield may also be attributed to functional role of potassium resulting is higher net photosynthetic activity and denser rooting system (Sharma *et al*., 1994). The low initial available sulphur content in experimental soil and 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 reflects the utility of sulphur in such crops (Biswas *et al*. 1995). Further, sulphur being an integral constituent of certain amino acids of which nitrogen is also an essential constituent, might have helped in increasing net assimilation rate of nitrogen and other nutrients. Thus, it might have resulted in increased yield attributes. These results are in agreement to the findings of Yadav *et al*. (2008) and Sharma (*2014*).

Effect of organic manures

Data presented in table-1 revealed that the neck thickness, number of scales per bulb, fresh weight of bulb and bulb yield 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 contains better levels of available nutrients, enhanced water holding capacity and leads to slow but steady release of macro and micro nutrients during the course of microbial decomposition (Singh and Ram, 1982). 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 plants and improves the physical properties of the soil (Singh and Singh, 1974). The beneficial response of Poultry manure and FYM to yield might also be attributed due to the availability of sufficient amount of plant nutrients throughout the growth period of crop, resulting in improved plant vigour and yield (Brar and Pastricha, 1998). The increased yield and yield parameters 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 underwent hydrolysis and got converted into reproductive sugars which ultimately helped in increasing yield. The carbohydrate content due to application of poultry manure might be attributed to balanced C: N ratio and increased metabolic activity of plant (Zarate *et al*., 1997). These results are in close conformity with the findings of Choudhary *et al*. (2013), Damse *et al*. (2014), Meena *et al*. (2014) and Meena *et al*. (2015).

Effect of bio-fertilizers

The result of present study (Table-1) clearly indicates that neck thickness, number of scales per bulb, fresh weight of bulb and bulb yield 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 a range soil borne fungal pathogens. It can also synthesise thiamine, riboflavin, pyridoxine, cyanocobal amine, 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, bulb development and ultimately 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 creates low oxygen involvement and help in fixing atmospheric nitrogen which reflected in the better yield parameters. Increased activity of plant growth substances like gibberellic acid, indole acetic acid, and dihydrozeatin in *Azospirillum* inoculated plant, greatly 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 helps 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 inoculants alone. Such mutually beneficial synergistic effects have also been reported by Yadav *et al.* (2008), Sharma (*2014*) and Meena *et al.* (2015).

Interaction effect

Interaction effect of different levels of fertility and organic manures were found to the significant for fresh weight of bulb and bulb yield. Maximum fresh weight of bulb and bulb yield (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}. The use of poultry manure in the absence of chemical fertilizer has remarkable effect in improving the fresh weight of bulb and bulb yield of onion. 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, 1986).The incorporation of organic manure in soil and its successive decomposition enabled the onion to ensure on almost continuous supply of nutrients 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.

1. 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.
2. The NPKS contained in the organic matter of the soil or the one added from external sources is liberated upon decomposition.
3. 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.* (2012), Choudhary *et al.* (2013), Damse *et al.* (2014) and Kumar *et al.* (2014).

Table 1. Effect of inorganic fertilizers, organic manures and bio-fertilizers on neck thickness, number of scales per bulb, fresh weight of bulb and bulb yield

Treatments	Neck thickness (cm)	Number of scales per bulb	Fresh weight of bulb (g)	Bulb yield (q ha^{-1})
Inorganic fertilizers				
F_0 (0% RD of NPKS)	0.85	6.64	40.20	186.10
F_1 (75% RD of NPKS)	1.00	7.34	64.84	300.18
F_2 (100% RD of NPKS)	1.03	7.47	65.88	305.00
SEm±	0.01	0.07	0.76	3.12
CD (P=0.05)	0.03	0.19	2.19	8.96
Organic manures				
M_0 (Control)	0.75	6.63	43.02	199.17
M_1 (FYM 20 t ha^{-1})	1.04	7.32	62.00	287.03
M_2 (Poultry Manure 5 t ha^{-1})	1.08	7.49	65.90	305.08
SEm±	0.01	0.07	0.76	3.12
CD (P=0.05)	0.03	0.19	2.19	8.96
Bio-fertilizers				
B_0 (No-inoculation)	0.89	6.62	43.64	202.05
B_1 (PSB inoculation)	0.96	7.26	59.93	277.47
B_2 (*Azospirillum* inoculation)	0.97	7.27	60.44	279.81
B_3 (PSB + *Azospirillum* inoculation)	1.02	7.46	63.87	295.71
SEm±	0.01	0.07	0.73	3.51
CD (P=0.05)	0.04	0.18	2.04	9.81

Table 2. Interactive effects of inorganic fertilizers and organic manures on fresh weight of bulb (g)

Treatments	M_0 (Control)	M_1 (FYM 20 t ha^{-1})	M_2 (Poultry Manure 5 t ha^{-1})	Mean
F_0 (0% RD of NPKS)	30.34	43.75	46.50	40.20
F_1 (75% RD of NPKS)	48.96	70.56	75.00	64.84
F_2 (100% RD of NPKS)	49.76	71.69	76.19	65.88
Mean	43.02	62.00	65.90	
SEm±	1.32			
CD (P=0.05)	3.79			

Table 3. Interactive effects of inorganic fertilizers and organic manures on bulb yield (q ha^{-1})

Treatments	M_0 (Control)	M_1 (FYM 20 t ha^{-1})	M_2 (Poultry Manure 5 t ha^{-1})	Mean
F_0 (0% RD of NPKS)	140.46	202.54	215.30	186.10
F_1 (75% RD of NPKS)	226.67	326.67	347.21	300.18
F_2 (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			

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