Study the effect of NPK through chemical fertilizers combination with FYM and bio-fertilizers on yield attributes of onion in Jaipur region of Rajasthan

Abstract

The field experiment was conducted in loamy sand soil of the Horticulture farm, Vivekanand Global University Jaipur, during *Rabi* season of 2020-21 and 2021-22.The experiment comprises of 32 treatment combinations replicated three times was laid out in split-plot design with four fertility levels of NPK (0,50, 75 and 100% of recommended dose of NPK) and two levels of FYM (without FYM and with FYM @ 25 t ha^{-1}) were added in main plots. Four bio-fertilizer levels (No inculcation N_2 fixer Azotobacter, PSB inculcation and N_2 fixer Azotobacter + PSB inoculation) were added in sub plots. The results of the study have clearly shown that application of chemical fertilizer up to 100% RDF increased all the yield attributes and yield (neck length, bulb diameter, number of scales, fresh weight of bulb, volume of bulb and yield). With application of FYM @ 25 t ha^{-1} significantly improved yield attributes and yield (neck length, bulb diameter, number of scales, fresh weight of bulb, volume of bulb and yield). Use of biofertilizers (N_2 fixers and PSB) alone or in combination increased all yield attributes and yield (neck length, bulb diameter, number of scales, fresh weight of bulb, volume of bulb and yield).

Keywords:FYM, Azotobacter, PSB inoculation, N_2 fixers and biofertilizers

Introduction

Onion (*Allium cepa* L.) is one of the most important commercial vegetable crops cultivated extensively in India and It is native of the Central Asia and Mediterranean region and commercially grown in China, India, U.S.A., erstwhile U.S.S.R.,Japan, Spain, Turkey, Brazil, Egypt etc it belongs to family Alliaceae. Onion is considered to be the second most important vegetable crop grown in the world after tomato. Onion is liked for its flavor and pungency in onion is due to presence of a volatile oil 'allyl propyl disulphide'- organic compound rich in Sulphur [1]. The beneficial compound called 'quercetin' present in onion is a powerful antioxidant [2].

In the world production of onion, India has second place after China. In the foreign exchange point of view, onion ranks first in vegetables. Yellow type onion constitutes a bulk (80%) of the world trade particularly in European market, red colored constitutes 20% of the world trade, major share of the market being in the Asian countries [3]. In India, only red onions are exported and our export is limited up to 20% of the world trade. India exports the onion to U.A.E., Malaysia, erstwhile U.S.S.R., Kuwait, Sri Lanka, Singapore etc. Maharashtra is the leading producer state of onion in India. It is mainly grown during *Rabi* season and harvested during summer in the month of April and May**.** In India, onion is grown in an area of 1.28 million ha with a production of 23.26 million ton and productivity 18.1 MT/ha as per Anonymous [4]. In India, the major onion producing states are Maharashtra, Madhya Pradesh, Karnataka, Gujarat etc. Maharashtra is the highest onion producing state contributing about 30.41 per cent. In Rajasthan, onion occupies an area 64.76 thousand ha with the production 996.73 thousand ton and productivity 15.39 MT/ha [4]. In Rajasthan, major onion producing districts are Jodhpur, Sikar, Nagaur, Alwar, Jaipur etc. It is a unique vegetable that is used throughout the year in the from the salador condiment or for cooking with other vegetables. Onion is also used in preparing souyps, sauces, curries, pickles and for flavouring or seasoning food [5].

Use of organic manure and biofertilizers in conjunction with chemical fertilizers has been found to be promising in not only sustaining higher productivity but also providing stability in crop production [6-7]. The farmyard manure seems to act directly for increasing crop yield by accelerating the respiratory process through cell permeability or by hormones through growth action [8]. In recent years, use of vermicompost has been advocated in integrated nutrient management (INM) system in vegetable crops. The pioneers of organic farming advise use of vermicompost as an organic manure and substitute for chemical fertilizer [9]. Biofertilizers are products containing living cells of different types of microorganism, which have an ability to convert nutritionally important elements to available form through biological processes Vijaykumar *et al.*[10].

Further, knowing the deleterious effect of using only chemical fertilizers on soil health, use of chemical fertilizers supplemented with organic waste and biofertilizers will be environmentally benign. Therefore, biofertilizers are widely accepted as low cost supplements to chemical fertilizers with no deleterious effect on either soil health or environment Bhagyaraj and Suvarna [11]. Among biofertilizers, Azotobacter strains play a key role in harnessing the atmospheric nitrogen through its fixation in the roots. VAM symbiosis facilitates plant growth through enhancing uptake of several macro and micro nutrients of low mobility in soil, like phosphorus, zinc and copper Dipankar [12].

Integrated nutrient management is an appropriate approach towards sustainable agriculture. Sustainable agriculture should involve successful management of resources for agriculture to satisfy changing human needs while maintaining or changing the environment and conserving natural resources. Integrated nutrient supply approach for the crop by judicious mixture of organic manure along with the inorganic fertilizers has a number of agronomical and environmental efficiency. Integrated system approach is not only the liable for attaining fairly high productivity with substantial fertilizer economy but also a concept of soundness leading to sustainable agriculture Swaminathan [13].

Method and Materials

The present experiment was conducted at Horticulture farm, Vivekanand Global University, Jaipur, during *Rabi* season of 2020-21 and 2021-22 was laid out in split-plot design in both the years with 32 treatment combinations replicated thrice. Jobner in situated at 26.5^0 North latitude, 75.20^0 East longitude and analtitude of 427 meters above mean sea level, in Jaipur district of Rajasthan. This region falls under Agro-climatic zone IIIA (Semi-AridEastern Plain)ofthestate. The climate of Jobner is typically semi-arid characterized by extremes of temperature both in summer and winter with lowrainfall and moderate relative humidity. Maximum temperature in summers is as high as 45 ^{0}C and minimum temperature in wintersfall around0 ^{0}C. To find out the effect of conjoint use of NPK through chemical fertilizers with FYM and bio-fertilizers on growth and yield of onion. The soil of experimental field was was loamy sand in texture, slightly alkaline in reaction, poor in organic carbon with low availablenitrogen,phosphorus andsulphurand medium in potassium status.

The treatments comprised of Chemical fertilizers, FYM and biofertilizers with ten treatments *Viz.,* F_0- Control, F_1-50% of recommended dose of NPK, F_2-75%ofrecommendeddoseofNPK, F_3-100%ofrecommendeddoseof NPK, M_0- Without FYM, M_1- With FYM @ 25 t ha $^{-1}$, B_0- No inoculation, B_1- N_2 fixer *Azotobacter*, B_2- PSB inoculation and B_3- N_2 Fixer *Azotobacter* + PSB inoculation, respectively. The treatments of chemical fertilizers, FYM, and bio-fertilizers were applied as per treatment in respective plot. 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 last week of May, 2020 and 2021.

Result and Discussion

Yield attributes

The data presented in table 1 indicate that neck thickness of bulb increased significantly with increasing level of fertility during both the years and in pooled mean. The application of NPK @ 100% RDF had significantly higher mean neck thickness of bulb by52.71, 19.32 and 4.12over control, 50 and75%RDF, respectively. It is further evident from data presented in table 1 that application of FYM @ 25 t ha^{-1} significantly increased the neck thickness of onion to the extent of13.56 per cent over no FYM application. use of different bio-fertilizer alone or in combination differently influenced the neck thickness of onion during both the years of investigation and in pooled analysis. Combined application of *Azotobacter* and PSB was observed to be the most superior treatment with regard to onion neck thickness (1.056 cm) that registered an increase of 25.94, 10.40 and 11.63 percent over control, *Azotobacter* and PSB, respectively.

Table 1: Effect of NPK, FYM and bio-fertilizers on neck thickness

Treatment	Neck thickness (cm)		
	2021-22	**2022-23**	**Pooledmean**
Fertilizers			
F_0 =Control	0.752	0.688	0.720
F_1 =50 %RDF	0.949	0.894	0.922
F_2 =75 %RDF	1.093	1.019	1.056
F_3 =100 %RDF	1.137	1.062	1.100
SEm$\pm$	0.018	0.020	0.013
CD(p=0.05)	0.053	0.059	0.039
FYM			
M_0=Control	0.902	0.858	0.880
M_1=25 t ha^{-1}	1.063	0.973	1.018
SEm$\pm$	0.013	0.014	0.009
CD(p=0.05)	0.038	0.041	0.027
Biofertilizers			
B_0 = Control	0.879	0.798	0.839
B_1 = Azotobacter	0.981	0.932	0.957
B_2 = PSB	0.976	0.916	0.946
B_3 = Azotobacter + PSB	1.095	1.017	1.056
SEm+	0.018	0.019	0.013

CD (p=0.05)	0.050	0.053	0.036

The data pertaining to neck length (cm) for both years and their pooled mean are presentedintable 2. The data revealed that different levels of fertility, FYM and biofertilizers significantly influenced the neck length during boththe years as well as inpooled analysis. Progressiveincrease in level of fertility from control to 100 % RDF brought aboutsignificantimprovement in neck length over preceding levels. The maximum neck length (6.96 cm) was recorded with the 100 % RDF which washigher by 41.65, 18.18 and 4.27 per cent over control, 50 and 75% RDF, respectively. However, the 75% and 100% RDF remained atpar during both the years and in pooled mean analysis. Application of FYM also had significant effect on neck length during both theyears as well as in pooled analysis. Application of FYM @ 25 t ha^{-1} increased the neck length to the extent of 21.69 per cent over no FYM application.

Use of bio-fertilizer alone or in combination was significantly beneficial in terms of neck length of bulb. Use of *Azotobacter* and PSB led to 11.20 and 7.23 per cent increase in neck length of bulb over no inoculation. The effect of combined use of *Azotobacter* along with PSB additive leading to an overall increase of 22.76 percent over to control in necklength of bulb. Table 3. shows that different levels of fertility, FYM and biofertilizers significantly influenced the equatorial diameter of bulb during both the years and in pooled analysis. The maximum mean equatorial diameter (7.15 cm) was observed with 100 % level of fertility followed by 75 % level of fertility (7.00 cm) but these were at par with each other. Minimum equatorial diameter was recorded in control (5.72 cm), which was 12.14, 22.36 and 24.98 per cent lower to 50, 75 and 100percent RDF, respectively.

Application of FYM also had significant effect on neck length during both the years as well as in pooled analysis. Application of FYM @ 25 t ha^{-1} increased the neck length to the extent of 21.69 per cent over no FYM application. It is also evident from the data that use of bio-fertilizers alone or in combination significantly increased the equatorial diameter of bulb. Use of *Azotobacter* and PSB increased the equatorial diameter to the extend of 16.62 and 13.87 per cent, respectively over control. However, combined application of *Azotobacter* + PSB represented the maximum increase of 22.57 per cent overno inoculation.

Table 2: Effect of NPK, FYM and bio-fertilizers on equatorial diameter of bulb

Treatment	Equatorialdiameterofbulb(cm)		
	2021-22	2022-23	Pooledmean
Fertilizers			

F_0 =Control	5.80	5.65	5.72
F_1 =50 %RDF	6.54	6.30	6.42
F_2 =75 %RDF	7.09	6.92	7.00
F_3 =100 %RDF	7.26	7.05	7.15
SEm±	0.09	0.09	0.06
CD(p=0.05)	0.26	0.26	0.18
FYM			
M_0=Control	5.85	5.75	5.80
M_1=25 t ha^{-1}	7.49	7.21	7.35
SEm±	0.06	0.06	0.04
CD(p=0.05)	0.18	0.18	0.12
Biofertilizers	6.35	6.50	
B_0 = Control	5.91	5.70	5.81
B_1 = Azotobacter	6.85	6.69	6.77
B_2 = PSB	6.70	6.52	6.61
B_3 = Azotobacter + PSB	7.22	7.01	7.12
SEm+	0.08	0.08	0.06
CD (p=0.05)	0.23	0.24	0.17

A critical study of the data presented in table 3 and appendices- 1, 2 indicated that polar diameter was significantlyincreased with every increase in level of fertility during both the years as well as in pooled analysis. Application of 50 and 75 %fertility levels represented the polar diameter of 6.57 and 2.75 cm, which was 12.04 and 15.13 per cent higher than control. However,application of 100 % RDF being at par with application of 75% RDF, witnessed the highest polar diameter (6.17 cm) and it registeredanincreaseof 15.13, 12.04 and 8.03 percentover control, 50 and 75%RDF, respectively.

Table 3: Effect of NPK, FYM and bio-fertilizers on polar diameter of bulb

Treatment	Polardiameterofbulb(cm)		
	2021-22	2022-23	Pooledmean
Fertilizers			
F_0 =Control	5.45	5.26	5.36
F_1 =50 %RDF	5.89	5.68	5.79
F_2 =75 %RDF	6.10	5.90	6.00
F_3 =100 %RDF	6.28	6.05	6.17
SEm±	0.09	0.09	0.06
CD(p=0.05)	0.26	0.26	0.18
FYM			
M_0=Control	5.78	5.61	5.70
M_1=25 t ha^{-1}	6.08	5.83	5.96
SEm±	0.06	0.06	0.04
CD(p=0.05)	0.18	0.19	0.13
Biofertilizers			
B_0 = Control	5.80	5.59	5.70
B_1 = Azotobacter	5.89	5.72	5.81
B_2 = PSB	5.85	5.66	5.76

B_3 = Azotobacter + PSB	6.18	5.92	6.05
SEm+	0.08	0.08	0.06
CD (p=0.05)	0.23	0.24	0.16

It may be conferred from the same data (Table 4) that FYM application to onion was found significantlysuperior incomparisonto control.Itregistered4.37 per centmorepolardiameter overnoapplication ofFYM.

Data pertaining to effect of different bio-fertilizers on polar diameter presented in table 4 indicated that polar diameter wasincreased appreciably by using the bio-inoculants in comparison to no inoculations. Microbial inoculation with*Azotobacter* + PSBwasthebesttreatmentinimprovingthepolardiameter.Theincreaseinpolardiameterdueto*Azoto bacter*+PSBwas6.23, 4.22 and 5.13percentovercontrol,*Azotobacter*andPSB,respectively.

Table 4: Effect of NPK, FYM and bio-fertilizers on number of scales per bulb

Treatment	Numberof scalesperbulb		
	2021-22	2022-23	Pooledmean
Fertilizers			
F_0 =Control	6.37	4.81	5.59
F_1 =50 %RDF	7.17	5.23	6.20
F_2 =75 %RDF	7.77	5.45	6.61
F_3 =100 %RDF	8.17	5.60	6.89
SEm±	0.10	0.09	0.07
CD(p=0.05)	0.30	0.26	0.19
FYM			
M_0=Control	7.03	5.16	6.10
M_1=25 t ha^{-1}	7.71	5.38	6.55
SEm±	0.07	0.06	0.05
CD(p=0.05)	0.21	0.19	0.14
Biofertilizers			
B_0 = Control	7.03	5.14	6.09
B_1 = Azotobacter	7.43	5.27	6.35
B_2 = PSB	7.34	5.21	6.28
B_3 = Azotobacter + PSB	7.68	5.47	6.58
SEm+	0.09	0.08	0.06
CD (p=0.05)	0.27	0.24	0.18

Datapertainingtotheeffectofintegratednutrientmanagementonnumberofscales per bulb arepresentedintable5. Application of different levels of fertility had significant influence on number of scales per bulb in both years as well as pooled analysis. With the increase in levels offertilityfromcontrolto100%RDF,asignificantincreaseinnumberofscalesperbulbwaso bserved.TheapplicationofNPK@100%RDFincreasethe mean number of scales per bulb by 23.17, 18.25 and 10.91 percentovercontrol,50and75%RDF,respectively.DatafurtherrevealedthatapplicationofFYMsignificantlyincreasedthenumberofscalesduringbothyearsandinpooledanalysis.TheFYM applied @ 25 tha^{-1}increased themean numberofscales by6.87 per cent overno FYM application.

Itis alsoclear from thedata that use of bio-fertilizers *viz Azotobacter*and PSB aloneorin combination significantlyincreasedthe number ofscalesper bulb.Useof*Azotobacter*andPSB increasedthenumberofscalesper bulbtotheextentof4.35and 3.12percent,respectivelyovercontrol.However,combinedapplicationof*Azotobacter*andPSBrepresentedthemaximumincreaseof8.05 percent over control.

Table 5: Effect of NPK, FYM and bio-fertilizers on fresh weight of bulb (g)

Treatment	Freshweightofbulb (g)		
	2021-22	**2022-23**	**Pooledmean**
Fertilizers			
F_0 =Control	38.77	37.76	38.26
F_1 =50 %RDF	47.57	46.64	47.10
F_2 =75 %RDF	55.06	53.89	54.47
F_3 =100 %RDF	57.04	55.93	56.48
SEm$\pm$	0.63	0.66	0.46
CD(p=0.05)	1.88	1.95	1.32
FYM			
M_0=Control	43.75	42.55	43.15
M_1=25 t ha^{-1}	55.47	54.55	55.01
SEm$\pm$	0.45	0.46	0.32
CD(p=0.05)	1.33	1.38	0.93
Biofertilizers			
B_0 = Control	45.45	44.05	44.75
B_1 = Azotobacter	50.40	49.65	50.03
B_2 = PSB	48.85	48.80	48.83
B_3 = Azotobacter + PSB	53.74	51.71	52.73
SEm+	0.57	0.62	0.42
CD (p=0.05)	1.62	1.76	1.19

Itisevidentfromthedatagivenin table 6 fresh weight of bulbinfluencedsignificantlyduetoapplicationofdifferentlevelsoffertilityduring both the years as well as inpooled analysis. Progressive increase in level of fertility to the soil rendered significantly higher fresh weight ofbulbupto100%RDF.Themaximummeanfreshweightof bulb(56.48g)wasobtainedatthislevel, whichwas47.62,42.37and23.11percenthigherovercontrol,50and75%RDF,respectivel y.

Application of FYM @ 25 t ha^{-1} significantly increased the fresh weight of bulb during both the years and in pooled mean (Table 6). Recording the fresh weight of bulb55.01 g it witnessed profound increase of 21.56 per cent in pooled analysis, over no FYMapplication.

Table 6: InteractioneffectofNPKandFYMonfreshweightofbulb(g)

RDFlevels	**FYMlevels**	
2021-22	M_0 =Control	M_1= 25 tha^{-1}
F_0 =Control	34.19	43.35
F_1 =50 %RDF	41.95	53.19
F_2 =75 %RDF	48.56	61.56
F_3 =100 %RDF	50.30	63.78
SEm$\pm$	0.90	
CD(p=0.05)	2.66	
2022-23		
F_0 =Control	33.09	42.42
F_1 =50 %RDF	40.87	52.40
F_2 =75 %RDF	47.23	60.55
F_3 =100 %RDF	49.02	62.84
SEm$\pm$	0.92	
CD(p=0.05)	2.76	
Pooled mean		
F_0 =Control	33.64	42.89
F_1 =50 %RDF	41.41	52.79
F_2 =75 %RDF	47.89	61.06
F_3 =100 %RDF	49.66	63.31
SEm$\pm$	0.65	
CD(p=0.05)	1.87	

It is also evident from the data (Table 7**)** that fresh weight of bulb was significantly improved due to all the inoculationtreatments during each year of study as well as in pooled analysis. Inoculation with *Azotobacter* and PSB significantly increased thefreshweight of bulbto thetuneof11.79and9.11per cent, respectively over control, whilemaximum fresh weight of bulb (52.73g) was obtained with the combined application of *Azotobacter* andPSB. Which was significantly 17.82, 5.40 and 7.99 per cent overcontrol,*Azotobacter* andPSB, respectively.

Fresh weight of bulb was also significantly affected due to combined effect of different dose of fertility and application of FYMduring both the years as well as in pooled analysis (Table 7). A perusal of pooled data presented in table 7 revealedthat application of 100 % RDF integrated with FYM @ 25 t ha^{-1} (F_3 M_1) recorded the significantly highest fresh weight of bulb(63.78 g) among all the treatment combinations. However, it was found statistically compatible with F_2 M_1 (61.56 g). These two treatment combinations significantly increased the fresh weight of bulb to the level of 55.57,47.12, 42.02, 26.79, 22.70 per cent, respectively over F_1M_1, F_3M_0, F_2M_0, $F_0M_1$and F_1M_0combinations,respectively.

Table 7: Effect of NPK, FYM and bio-fertilizers on volume of bulb (cm3)

Treatment	Volumeof bulb(cm^3)		
	2021-22	2022-23	Pooledmean
Fertilizers			
F_0 =Control	42.09	41.16	41.63
F_1 =50 %RDF	48.55	47.45	48.00
F_2 =75 %RDF	54.05	52.81	53.43
F_3 =100 %RDF	57.65	57.01	57.33
SEm$\pm$	0.85	0.93	0.63
CD(p=0.05)	2.53	2.75	1.82
FYM			
M_0=Control	48.41	47.88	48.15
M_1=25 t ha^{-1}	52.76	51.33	52.05
SEm$\pm$	0.60	0.66	0.44
CD(p=0.05)	1.79	1.95	1.29
Biofertilizers	8.24	9.15	
B_0 = Control	46.09	46.31	46.20
B_1 = Azotobacter	50.49	50.31	50.40
B_2 = PSB	50.34	50.01	50.18
B_3 = Azotobacter + PSB	55.42	51.80	53.61
SEm+	0.62	0.67	0.46
CD (p=0.05)			

The results (Table 8) showed that volume of bulb was significantly affected by different levels offertility in both years of study as well as pooled analysis. The mean data for both the years clearly indicate that 100 % RDF hadmaximum volume of bulb (57.33 cc) followed by 75 % (53.43 cc) and 50 % (48.00 cc) RDF. The mean volume of bulb with thetreatment100 % RDF was 37.73,28.36 and 15.32 per cent moreovercontrol, 50 and

75%RDF,respectively.Volume of bulb was also influenced significantly by application of FYM in comparison to control. It registered 7.49 per centmorevolumeof bulb over no application ofFYM(Table8).

Data from table 8 further indicate that inoculation of biofertilizers had significant effect on volume of bulb during both theyears as well as pooled analysis. The highest mean volume of bulb was observed under inoculation with *Azotobacter* + PSB (53.61 cc)whichwas significantlysuperior overcontrol (46.20 cc), *Azotobacter*(50.40 cc) and PSB(50.18 cc).It is in close conformity with the findings of [21].

Table 8: Effect of NPK, FYM and bio-fertilizers on bulb yield per hectare (q)

Treatment	Bulbyieldperhectare(q)		
	2021-22	2022-23	Pooledmean
Fertilizers			
F_0 =Control	169.89	164.08	166.98
F_1 =50 %RDF	215.11	211.63	213.37
F_2 =75 %RDF	252.57	244.34	248.45
F_3 =100 %RDF	259.63	253.67	256.65
SEm$\pm$	3.58	3.92	2.66
CD(p=0.05)	10.64	11.65	7.69
FYM			
M_0=Control	190.28	183.39	186.84
M_1=25 t ha^{-1}	258.31	253.47	255.89
SEm$\pm$	2.53	2.77	1.88
CD(p=0.05)	7.52	8.24	5.44
Biofertilizers			
B_0 = Control	213.77	205.58	209.68
B_1 = Azotobacter	226.92	222.62	224.77
B_2 = PSB	226.14	218.08	222.11
B_3 = Azotobacter + PSB	230.36	227.44	228.90
SEm+	2.36	2.57	1.75
CD (p=0.05)	6.69	7.28	4.91

Data presented in table 9 revealed that bulb yield of onion was significantly influenced byapplicationofdifferentlevelsoffertilityduringboththeyearsaswellasinpooledanalysis.Progressiveincreaseinlevelsoffertilityto the soil rendered significantly higher yield of onion bulbs upto 100 %RDF. The maximum mean bulb yield of 259.63 q ha^{-1} wasobtained at this level which was 53.70, 20.29 and 3.30 per cent higher in comparison to control, 50 and 75 % RDF, respectively.Itwas followed accompanied by 75 and 50 % RDF which also witnessed 48.79 and 16.44 improvement in bulbyield of onionrespectively,over controlin pooled analysis. It is in close conformity with the findings of [20].

Table 9: Interaction effect of NPK and FYM on bulb yield per hectare (q)

RDFlevels	FYMlevels	
2021-22	**M_0 =Control**	**M_1= 25 tha^{-1}**
F_0 =Control	144.12	195.65
F_1 =50 %RDF	182.49	247.73
F_2 =75 %RDF	214.26	290.87
F_3 =100 %RDF	220.25	299.00
SEm±	5.06	
CD(p=0.05)	15.05	
2022-23		
F_0 =Control	137.52	190.64
F_1 =50 %RDF	177.37	245.88
F_2 =75 %RDF	205.07	283.61
F_3 =100 %RDF	213.61	293.74
SEm±	5.55	16.48
CD(p=0.05)	16.48	
Pooled mean		
F_0 =Control	140.82	193.15
F_1 =50 %RDF	179.93	246.81
F_2 =75 %RDF	209.67	287.24
F_3 =100 %RDF	216.93	296.37
SEm±	3.75	
CD(p=0.05)	10.88	

It is clear from the data presented in the same table that application of FYM @ 25 t ha^{-1} significantly enhanced the bulb yieldof onion as compared with control. It is further evident from the data that use of different biofertilizers alone or in combination differentially influenced the bulbyield of onion during both the years of investigation and in pooled analysis. Use of *Azotobacter* and PSB remaining at par with eachother significantly increased the bulb yield of onion to the extent of 7.20and 5.93 per cent respectively, over control. However,combined application of *Azotobacter* and PSB observed to be the most superior treatment with regard to onion bulb yield (228.44 q ha^{-1}) that registered a quantum increase of9.17, 1.84 and 3.06 q ha^{-1} overcontrol,*Azotobacter*, and PSB, respectively.It is in close conformity with the findings of [19].

Table 10: Interaction effect of NPK and FYM on bulb yield per hectare (q)

RDFlevels	FYMlevels	
2021-22	**M_0 =Control**	**M_1= 25 tha^{-1}**
F_0 =Control	144.12	195.65
F_1 =50 %RDF	182.49	247.73
F_2 =75 %RDF	214.26	290.87
F_3 =100 %RDF	220.25	299.00
SEm±	5.06	
CD(p=0.05)	15.05	

2022-23		
F_0 =Control	137.52	190.64
F_1 =50 %RDF	177.37	245.88
F_2 =75 %RDF	205.07	283.61
F_3 =100 %RDF	213.61	293.74
SEm±	5.55	16.48
CD(p=0.05)	16.48	
Pooled mean		
F_0 =Control	140.82	193.15
F_1 =50 %RDF	179.93	246.81
F_2 =75 %RDF	209.67	287.24
F_3 =100 %RDF	216.93	296.37
SEm±	3.75	
CD(p=0.05)	10.88	

Interactive effect of different levels of fertility and FYM application on bulb yield during both years as well as pooled data wasalso significant (Table 10). The data revealed that irrespective of FYM application the increasinglevel of fertilizers upto 75% RDF brought significant improvement in bulb yield of onion. Irrespective of fertility levels, the FYM application @ 25 tha^{-} recordedsignificanthigherbulbyieldovercontrol.Ingeneral,thecombinedapplicationofF_2M_1(75 %RDF+25tha^{-1}FYM)remain significantlyhigheroverotherrestoftreatments.However,thistreatmentcombinationwasstatisticallyatparwithF_3M_1(100%RDF+25t ha^{-1}FYM). The present trend of increase in bulb yield in K application of nitrogen is in close conformity with the findings of Vachhani and Patel [14],[15-18].

Conclusion

Maximum neck thickness, neck length, bulb diameter (equatorial and polar), number of scales per bulb, fresh weight of bulb, volume of bulb and bulb yield per hectare was recorded with 100% RDF fertility level. yield attributes viz. neck thickness, neck length, bulb diameter (equatorial and polar) number of scales per bulb, fresh weight of bulb, volume of bulb and bulb yield per hectare were significantly enhanced with the application of FYM. the combined application of biofertilizers viz. azotobacter + PSB exhibited the maximum increase in yield attributes although inoculation with azotobacter and PSB alonesignificantly increased the yield attributes over no inoculation.

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