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The interaction effect of FYM, fertilizers and bio-fertilizers on yield attributes of onion

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Abstract
The studied carried out interaction effect of FYM, fertilizers (inorganic fertilizers-NPK) and bio-fertilizers (PSB inoculation and *Azospirillum* inoculation) on Yield attributes (neck thickness, Equatorial diameter and Polar diameter) of bulbs of 12 onion cultivars. The effect of organic manure M_0 (Control), M_1 (FYM 10 t ha^{-1}) and M_2 (FYM 20 t ha^{-1}) and effect of inorganic fertilizers at F_0 (0% RD of NPK), F_1 (50% RD of NPK) and F_2 (100% RD of NPK) and effect of bio-fertilizers at B_0 (No-inoculation), B_1 (PSB inoculation) and B_2 (*Azospirillum* inoculation) observed varied in onion bulbs. The result of present study clearly revealed that the neck thickness, equatorial and polar diameter of bulb, bulb yield of onion crop increased significantly with the application of FYM, significantly affected by 100% RDF of inorganic fertilizers and less significantly due to inoculation of *Azospirillum* and PSB respectively. The experiment was laid out at College Farm, College of Agriculture, S.K. Rajasthan Agricultural University, Bikaner, during *"Rabi"* season of 2015-16 and 2016-17.

Keywords: onion, yield attridutes, FYM, NPK, bio-fertilizers

Introduction
Onion (*Allium cepa* L.), is a member of family Alliaceae and mostly as a biennial herb. Nutritive value of onion varies variety to variety; Small size onion is more nutritive than big size onion. Onion ranks medium in caloric, low in protein and very low in Vitamins, studied the interaction effect FYM, fertilizers and bio-fertilizers on bulbs of 12 onion cultivars and effect of inorganic fertilizers observed that the neck thickness of bulbs varied from 0.825 to 0.835 cm, for equatorial diameter of bulbs varied from 6.065 to 6.170 and for Polar diameter varied from 0.027 to 0.038 and the effect of organic manure observed that the neck thickness of bulbs varied from 0.785 to 0.801 cm, for equatorial diameter of bulbs varied from 5.662 to 5.824 and for Polar diameter varied from 4.690 to 4.788 and the effect of bio-fertilizers observed that the neck thickness of bulbs varied from 0.765 to 0.772 cm, for equatorial diameter of bulbs varied from 5.446 to 5.543 and for Polar diameter varied from 4.560 to 4.608.

Material and Method
The experiment was laid out at College Farm, College of Agriculture, S.K. Rajasthan Agricultural University, Bikaner, during *"Rabi"* season of 2015-16 and 2016-17. Geographically, experimental site is situated at an altitude of 234.70 meters above mean sea level and latitude of 280 01' N and longitude of 730 22' E. According to "Agro ecological region map" brought by NBSS&LUP, Bikaner falls under Agro ecological region No.2 (M9E1) under arid ecosystem (Hot Arid Eco-region with desert and saline soils), which is characterized by deep, sandy and coarse loamy, desert soils with low water holding capacity, hot and arid climate and annual precipitation is less than 300 mm.
The experiment was conducted on onion variety N-53. The experiment comprising of 27 treatment combinations and replicated three times, was laid out in Factorial RBD with three fertility levels (0, 50 and 100% of recommended dose of NPK), three treatments of organic manure (control, FYM @ 10 t ha^{-1} and FYM @ 20 t ha^{-1}) and three bio-fertilizers (No inoculation, PSB inoculation and Azospirillum inoculation) were applied in the plots. The treatments of manure, chemical fertilizers and bio-fertilizers were applied as per treatment in respective plot.

The experimental data recorded were subjected to statistical analysis using analysis of variance technique suggested by Panse and Sukhatme (1985) [10]. The critical differences for the treatment comparison were worked out, wherever the 'F' test was found significant at 5 per cent level of significance.

Results and Discussion

The result of study (Table-1) for neck thickness of bulbs treated with 100% RD of NPK was recorded maximum (0.835 cm, 0.825 cm and 0.830 cm) followed by 50% RD of NPK (0.778 cm, 0.769 cm and 0.774 cm) at the time of harvesting in the years 2015-16, 2016-17 and as well as on pooled basis, respectively. The result also indicated that the neck thickness of bulb in control was recorded minimum (0.672 cm, 0.667 cm and 0.670 cm) in both the years and on pooled basis. Furthermore, it is also to mention that the neck thickness of bulbs treated with 100% RD of NPK was also significantly more over the control and 50% RD of NPK. It was also found that there was 23.88% and 15.52% increase in neck thickness of bulbs treated with 100% and 50% RD of NPK as compared to control.

For equatorial diameter of bulbs (Table-1) treated with 100% RD of NPK was recorded maximum (6.170 cm and 6.065 cm) followed by 50% RD of NPK (5.552 cm and 5.462 cm) at the time of harvest in both the years 2015-16, 2016-17, respectively. The result also indicated that equatorial diameter of bulb in control was recorded minimum (4.583 cm and 4.540 cm) in both the years 2015-16, 2016-17 respectively. On overall pooled basis, it was found that the average equatorial diameter of bulbs was recorded maximum in 100% RD of NPK (6.118 cm) which is also statistically significant as compared to control (4.562 cm). Furthermore, it is also to mention that the equatorial diameter of bulbs treated with 100% RD of NPK was also significantly more over the control and 50% RD of NPK. It was also found that there was 34.10% and 20.71% increase in equatorial diameter of bulbs treated with 100% and 50% RD of NPK as compare to control.

The results data presented (Table-1) the polar diameter of bulbs treated with 100% RD of NPK was recorded maximum 5.028 cm, 4.966 cm and 4.997 followed by 50% RD of NPK (4.615 cm, 4.560 cm and 4.588 cm) at the time of harvesting in the years 2015-16, 2016-17 and as well as on pooled basis, respectively. The result also indicated that polar diameter of bulb in control was recorded minimum (3.996 cm, 3.967 cm and 3.982 cm) in both the years and on pooled basis. Furthermore, it is also to mention that the polar diameter of bulbs treated with 100% RD of NPK was also significantly more over the control and 50% RD of NPK. It was also found that there was 25.48% and 15.21% increase in polar diameter of bulbs treated with 100% and 50% RD of NPK as compared to control.

The result of present study clearly revealed that neck thickness, equatorial and polar diameter of bulb, bulb yield of onion crop (Table-1) significantly affected by 100% RDF of inorganic fertilizers over the control and 50% RDF of inorganic fertilizers. The increase in this 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. This is due to increased synthesis of chlorophyll content which in turn resulted in enhanced net assimilation rate by the increased photosynthetic activities. Thus, it also resulted increase equatorial and polar diameter. Moreover, the nitrogen application might have influenced the availability of other nutrients especially phosphorus and Sulphur and thus better nutrition, ultimately leading to increased yield attributing (neck thickness, equatorial and polar diameter of bulb) and yield according to Meena (2015) [6] and Mahala (2015) [4].

The beneficial influence of phosphorus in early stage of growth may be explained by early stimulation of the root system through efficient translocation to roots of certain growth stimulating compounds formed on account of protoplasmic activity of tops in phosphorus fed plants. Generally, these factors enhance the absorption of nitrogen and other nutrients and their utilization. The increase in yield and yield attributes may also be due to functional role of potassium resulting in higher net photosynthetic activity and denser rooting system. These results are in agreement with findings of Channagoudra (2004) [1], Mondal *et al*. (2004) [7], Yadav *et al*. (2008) [12] and Sharma (2014) [11]. The data presented in (Table-1) revealed that the neck thickness of bulbs applied with FYM @ 20 t ha^{-1} was recorded maximum (0.801 cm, 0.785 cm and 0.793 cm) followed by FYM @ 10 t ha^{-1} (0.769 cm, 0.764 cm and 0.766 cm) in the years 2015-16, 2016-17 and as well as on pooled basis, respectively. The result also indicated that neck thickness of bulb in control was recorded minimum (0.716 cm, 0.712 cm and 0.714 cm) in both the years and on pooled basis. Both the treatments showed statistically significant higher neck thickness of bulb than control. It was also found that there was 11.06% and 7.28% increase in neck thickness of bulb treated with FYM @ 20 t ha^{-1} and 10 t ha^{-1} as compared to control (FYM @ 0 t ha^{-1}).

The data presented in (Table -1) revealed that the equatorial diameter of onion bulbs applied with FYM @ 20 t ha^{-1} was recorded maximum 5.824 cm, 5.662 cm and 5.743 cm followed by FYM @ 10 t ha^{-1} 5.495 cm, 5.449 cm and 5.472 cm in both the years of 2015-16, 2016-17 and on pooled basis, respectively. The result also indicated that equatorial diameter of onion bulbs in control was recorded minimum 4.986 cm, 4.957 cm 4.971 cm and in both the years 2015-16, 2016-17 and on pooled basis. Both the treatments showed statistically significant higher equatorial diameter of onion bulbs than control and FYM @ 10 t ha^{-1}. It was also found that there was 15.53% and 10.07% increase in equatorial diameter of onion bulbs treated with FYM @ 20 t ha^{-1} and 10 t ha^{-1} as over the control.

The polar diameter of bulbs applied with FYM at the rate of 20 t ha^{-1} was recorded maximum (4.788 cm, 4.690 cm and 4.739 cm) followed by FYM @ 10 t ha^{-1} (4.588 cm, 4.560 cm, 4.574 cm) in the years of 2015-16, 2016-17 and on pooled basis, respectively. The result also indicated that polar diameter of bulbs in control was recorded minimum (4.263 cm, 4.243 cm and 4.253 cm) in the years 2015-16, 2016-17 and on pooled basis. Both the treatments showed statistically significant higher polar diameter of bulbs than control. It was also found that there was 11.42% and 7.54% increase in polar diameter of bulbs treated with FYM at the rate of 20 t ha^{-1} and 10 t ha^{-1} as compared to control.

Data presented in (Table-1) revealed that the neck thickness, equatorial and polar diameter of bulb, bulb yield of onion crop increased significantly with the application of FYM @ 20 t ha^{-1} over the control and FYM @ 10 t ha^{-1}. FYM contains macro and micronutrients, enhance water holding capacity and release macro and micro nutrients during the microbial decomposition. Organic matter is also a source of energy for soil micro flora which brings the transformation of soil inorganic nutrients in the readily available form which, is utilized by growing plant and also improve the physical

properties of the soil. The beneficial response of 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 (Brar and Pastricha, 1998). The increased yield and yield attributes (neck thickness, equatorial and polar diameter of bulb) with FYM 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 productive sugars which ultimately helped in increasing yield. The carbohydrates content due to application of FYM might be attributed to balanced C:N ratio and increased activity of plant metabolisms (Zarate *et al*., 1997) [13]. These results are also in close conformity with the findings of Meena *et al*. (2014) [5], Nandeshwar *et al*. (2014) [8], Farooq *et al*. (2015) [8].

The results pertaining to the impact of bio-fertilizer treatments on neck thickness of onion bulb have been presented (Table-1). The data indicated that all the bio-inoculants significantly enhanced the neck thickness of onion bulb over the control. The results indicated that the maximum neck thickness of bulbs was recorded (0.772 cm, 0.765 cm and 0.768 cm) with *Azospirillum* treatment followed by PSB treatment (0.766 cm, 0.753 cm and 0.759 cm) in the years 2015-16, 2016-17 and as well as on pooled basis, respectively. The result also indicated that neck thickness of bulb in control was recorded minimum (0.747 cm, 0.744 cm and 0.745 cm) in both the years and on pooled basis. The *Azospirillum* and PSB also showed 3.08% and 1.87% increase in neck thickness of bulbs in comparison to the control, respectively. The data also indicated that increase in neck thickness in the bulbs treated with *Azospirillum* and PSB was statistically at par but significantly higher than control.

Similarly, the data pertaining to the impact of bio-fertilizer treatments on equatorial diameter of onion bulb have been presented (Table-1). The data indicated that all the bio-inoculants significantly enhanced the equatorial diameter of onion bulbs over the control. The results indicated that the maximum equatorial diameter of bulbs was recorded in *Azospirillum* treatment (5.543 cm, 5.446 cm and 5.494 cm) followed by PSB treatment (5.482 cm,5.346 cm and 5.414 cm) in the years 2015-16, 2016-17 and as well as on pooled basis, respectively. The result also indicated that equatorial diameter of bulbs in control was recorded minimum in (5.281 cm, 5.275 cm and 5.278cm) during both the years and on pooled basis.

The *Azospirillum* and PSB also showed 4.09% and 2.57% increase in equatorial diameter of bulbs in comparison to the control, respectively. The data also indicated that increase in equatorial diameter in the bulbs treated with *Azospirillum* and PSB was statistically at par but significantly higher than control.

The data pertaining to the impact of bio-fertilizer treatments on polar diameter of onion bulb have been presented in Table 1. The data indicated that all the bio-inoculants significantly enhanced the polar diameter of onion bulb over the control. The results indicated that the maximum polar diameter of bulbs was recorded in *Azospirillum* treatment (4.608 cm, 4.560cm and 4.584 cm) followed by PSB treatment (4.574 cm, 4.491 cm, 4.532 cm)in the years 2015-16, 2016-17 and as well as on pooled basis, respectively. The result also indicated that polar diameter of bulb in control was recorded minimum (4.457 cm, 4.445 cm and 4.451 cm) in the years 2015-16, 2016-17and on pooled basis. The *Azospirillum* and PSB also showed 2.98% and 1.78% increase in polar diameter of bulbs in comparison to the control, respectively. The data also indicated that increase in polar diameter in the bulbs treated with *Azospirillum* and PSB was statistically at par but significantly higher than control.

The result of present study (Table-1) clearly indicated that neck thickness, equatorial and polar diameter of bulb and bulb yield of onion crop increased less significantly due to inoculation of *Azospirillum* and PSB. Bio-fertilizer treatments indicated that increased in yield attributes (neck thickness, equatorial and polar diameter of bulb) of onion crop treated with *Azospirillum* and PSB was statistically at par but significantly higher than control. 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. These results are also in close conformity with the findings of Gunjun *et al*. (2005), Yadav *et al*. (2008) [12].

Increased levels of organic manure with 100% RDF might have acted as sufficient source of energy to bio-fertilizers, *Azospirillum* and PSB, which enhanced higher release of P in soluble form and more fixation of atmospheric N. Enhance N availability of P thus recorded higher bulb yield.

Table 1: Interaction effect of inorganic fertilizers, organic manure and bio-fertilizers on neck thickness (cm), equatorial diameter (cm) and polar diameter (cm) of bulb at harvest of onion

Treatments	Neck thickness (cm)			Equatorial diameter (cm)			Polar diameter (cm)		
Inorganic fertilizers	**2015-16**	**2016-17**	**Pooled**	**2015-16**	**2016-17**	**Pooled**	**2015-16**	**2016-17**	**Pooled**
F_0 (0% RD of NPK)	0.672	0.667	0.670	4.583	4.540	4.562	3.996	3.967	3.982
F_1 (50% RD of NPK)	0.778	0.769	0.774	5.552	5.462	5.507	4.615	4.560	4.588
F_2 (100% RD of NPK)	0.835	0.825	0.830	6.170	6.065	6.118	5.028	4.966	4.997
SEm±	0.006	0.006	0.004	0.060	0.058	0.042	0.038	0.037	0.027
CD (P=0.05)	0.018	0.017	0.012	0.171	0.165	0.117	0.109	0.106	0.075
Organic manure									
M_0 (Control)	0.716	0.712	0.714	4.986	4.957	4.971	4.263	4.243	4.253
M_1 (FYM 10 t ha^{-1})	0.769	0.764	0.766	5.495	5.449	5.472	4.588	4.560	4.574
M_2 (FYM 20 t ha^{-1})	0.801	0.785	0.793	5.824	5.662	5.743	4.788	4.690	4.739
SEm±	0.006	0.006	0.004	0.060	0.058	0.042	0.038	0.037	0.027
CD (P=0.05)	0.018	0.017	0.012	0.171	0.165	0.117	0.109	0.106	0.075
Bio-fertilizers									
B_0 (No-inoculation)	0.747	0.744	0.745	5.281	5.275	5.278	4.457	4.445	4.451
B_1 (PSB inoculation)	0.766	0.753	0.759	5.482	5.346	5.414	4.574	4.491	4.532
B_2(*Azospirillum* inoculation)	0.772	0.765	0.768	5.543	5.446	5.494	4.608	4.560	4.584

SEm±	0.006	0.006	0.004	0.060	0.058	0.042	0.038	0.037	0.027
CD (P=0.05)	0.018	0.017	0.012	0.171	0.165	0.117	0.109	0.106	0.075

Conclusion

Finding of research work concluded that interaction of application of organic manure, Inorganic fertilizer and bio-fertilizer, influenced the yield attributes and quality of onion bulb. The yield attributes neck thickness (cm), equatorial diameter (cm) and polar diameter (cm) of bulb of onion influenced through 0% RD of NPK, 50% RD of NPK, 100% RD of NPK and control, FYM 10 t ha^{-1} and FYM 20 t ha^{-1} and No- inoculation, PSB inoculation and *Azospirillum* inoculation by application of Inorganic fertilizers, Organic manure and bio-fertilizers respectively.

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