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Effect of levels of FYM, fertilizers and Bio-fertilizers on quality of onion (*Allium cepa* L.) cv. N-53

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Abstract
The "Effect of levels of FYM, fertilizers and biofertilizers on quality attributes of onion (*Allium cepa*L.) cv. N-53" in sandyloam soils. 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 @ 20 t ha^{-1} and FYM @ 10 t ha^{-1}) and three bio-fertilizers (No inoculation, PSB inoculation and Azospirillum inoculation) were applied in the plots. The results of the study have clearly shown that highest TSS and Ally- propyl- disulphide were observed in FYM @ 20 t^{-1} followed by inorganic fertilizers @ 100% RDF and *Azospirillum.* While the lowest content of TSS and Ally- propyl- disulphide in onion bulb were observed in control (M_0) followed by no inoculation (B_0) and control(F_0). In arid region, the soil nature is sandy loam and it's deficient in nutrient content. So, increasing application level of manure, fertilizer and bio-fertilizer responds to crops for its quality. Further it may be concluded that application of 20 t ha^{-1} FYM and 100% RD of NPK is worth recommendable for farmers of arid region to make better quality of onion in nutrient deficient soil of arid region.

Keywords: Onion, T.S.S., Ally-propyl-disulphide, *Azospirillum,* PSB, quality, fertilizers, organic manure

Introduction
Onion (*Allium cepa*L.) is one of the most important commercial vegetable crops cultivated extensively in India and it belongs to family Alliaceae. India ranks second in onion production, which shares 12.81 per cent of total vegetable production. It produces about 21.71 million tonnes onion from an area of 1.29 million hectares and productivity of 16.83 MT ha^{-1}.Nutritive value of onion varies variety to variety; small size onion is more nutritive than big size onion and colour of skin and nutrient applications etc. Onion ranks medium in caloric, low in protein and very low in Vitamins (Manach *et al.* 1998) Bajaj *et al.* (1980) [1] studied the chemical composition of various varieties observed that the dry matter varied from 10.66 to 14.80 per cent, TSS, reducing sugars 12 to 22.25 per cent and phenols 1.75 to 2.95 per cent on dry matter basis. It gives a distinctive and pungent odour, when tissues are crushed due to a colourless, odourless volatile compound in very small quantity (approx. 0.005%) known as allyl propyl disulphide ($C_6H_{12}O_2$). The productivity of onion in India is quite low as compared to world's productivity. So, there is an acute shortage of onion in relation to its requirement. This can be done by many ways of which the most important are the continuous and liberal use of inorganic fertilizer alone affects soil health thus resulting in lower yield with poor quality produce (Mamatha, 2006) [9]. Plant nutrition plays an important role for enhancing yield and quality in onion. Integrated Plant Nutrition System (IPNS) is 'the management of all available plant nutrient sources, organic and inorganic to provide optimum and sustainable crop production conditions within the prevailing farming system' (BARC, 2005) [2]. In India, researcherwere revealed that the integrated nutrient management with organic and inorganic fertilizers to conserve the soil health and to get good quality produce.In this view, to conduct the experiments under *Thar* dessert where the nutrient status is very poor to get optimum yield with quality bulbs.

Materials and Methods
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, annual PET ranges between 1500 to 2000 mm. According to NARP, it is known as Hyper Arid Partially Irrigated North Western Plain zone.

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. FYM were applied prior to 15 days of transplanting of Onion. PSB and *Azospirillum* bio-fertilizer was applied at the time of transplanting. Nutrient like nitrogen, phosphorus and potassium were applied through urea, single super phosphate and muriate of potash, respectively as per experimental plan. 1/3 dose of N and K with full dose of P as a basal dose and remaining dose of N and K in two splits with irrigation at 30 and 60 days of transplanting respectively. The onion variety used in the experiment was "N-53". 45 days old seedlings of uniform growth were transplanted in evening hour at a spacing of 15x10 cm in flat beds. The gross plot size was 1.8 m x 1.8 m^2. The fertilizer applications were done as NPK @100:50:100kg ha^{-1} and Bio-fertilizers @ 1kg per 15 liter of water seedlings treatment. Observations of quality parameters of onion bulbs like TSS (°Brix) and Allyl propyl disulphide were estimated by hand Refractometer and Hort and Fisher (1971) respectively.

Result and Discussion

The results in (Table- 1 and 2) are clearly indicated that the total soluble solids (T.S.S.) of onion bulbs treated with 100% RD of NPK was recorded maximum 11.87%, 11.93% and 11.90% followed by 50% RD of NPK 11.68%,11.76% and 11.72% in both the years 2015-16, 2016-17 and as well as on pooled basis, respectively. Total soluble solid (T.S.S.) of onion bulbs in control was recorded minimum 11.33%, 11.43% and 11.38% in both the years 2015-16, 2016-17 and on pooled basis. It was 4.56% and 2.98% increased in total soluble solids (T.S.S.) of onion bulbs treated with 100% and 50% RD of NPK as compared to control. Whereas, the allyl propyl disulphide content applied with 100% RD of NPK was recorded maximum 6.61 mg 100 g^{-1}, 6.92 mg 100 g^{-1} and 6.76 mg g^{-1} followed by 50% RD of NPK 6.27 mg 100 g^{-1}, 6.74 mg 100 g^{-1} and 6.51 mg g^{-1} atthe time of harvesting in both the years 2015-16, 2016-17 and as well as on pooled basis, respectively. The allyl propyl disulphide content in control was recorded minimum 5.67 mg 100 g^{-1}, 6.28 mg 100 g^{-1} and 5.97 mg 100^{-1} in both the years 2015-16, 2016-17 and on pooled basis. However, the increased in allyl propyl disulphide content in onion bulbs treated with 100% RD of NPK and 50% RD of NPK were statistically significantly higher than control.It suggests that the application of increasing levels of fertility may be attributed to better nutrient uptake by the root zone owing to better development of nutritional environment nearby rhizosphere. It also plays an important role in plant metabolism by virtue of being an essential compound like amino acids, protein, nucleic acids, enzymes, coenzymes and alkaloids (Yadav, 2000, Mahala, 2015 and Meena, 2016) [21, 8]. NPK application significantly increased the TSS and Allyl propyl disulphide in onion bulb. Both content significantly increased with the nitrogen application which helped in vigorous vegetative growth and imparted deep green colour to the foliage which favored photosynthetic activity of the plants so there was greater accumulation of food material i.e. carbohydrates in the bulb leading to increase TSS and pungency content. The similar results have also been reported by Singh *et al*. (1989) [16], Gamiely *et al*. (1991) [5], Pandey *et al*. (1991) [13], Vachhani and Patel (1993) [20] and Thabet *et al*. (1994). These results are also in accordance with the findings of Zeinani *et al*. (2010) [22], Hariyappa *et al*. (2011) [7], Tripathy *et al*. (2010) and Sharma (2014) [15].

Table 1: Effect of inorganic fertilizers, organic manure and bio-fertilizers on total soluble solids in bulb (°Brix)

Treatments	TSSº B		
Inorganic fertilizers	**2015-16**	**2016-17**	**Pooled**
F_0 (0% RD of NPK)	11.33	11.43	11.38
F_1 (50% RD of NPK)	11.68	11.76	11.72
F_2 (100% RD of NPK)	11.87	11.93	11.90
SEm±	0.06	0.04	0.04
CD (P=0.05)	0.18	0.12	0.11
Organic manure			
M_0 (Control)	11.10	11.19	11.15
M_1 (FYM 10 t ha^{-1})	11.75	11.82	11.79
M_2 (FYM 20 t ha^{-1})	12.03	12.10	12.07
SEm±	0.06	0.04	0.04
CD (P=0.05)	0.18	0.12	0.11
Bio-fertilizers			
B_0 (No-inoculation)	11.27	11.37	11.32
B_1 (PSB inoculation)	11.69	11.76	11.72
B_2 (*Azospirillum* inoculation)	11.93	11.99	11.96
SEm±	0.06	0.04	0.04
CD (P=0.05)	0.18	0.12	0.11

Table 2: Effect of inorganic fertilizers, organic manure and bio-fertilizers on allyl propyl disulphide content of bulb (mg 100 g^{-1})

Treatments Allyl propyl disulphide (mg 100 g-1)			
Inorganic fertilizers	**2015-16**	**2016-17**	**Pooled**
F_0 (0% RD of NPK)	5.67	6.28	5.97
F_1 (50% RD of NPK)	6.27	6.74	6.51
F_2 (100% RD of NPK)	6.61	6.92	6.76
SEm±	0.08	0.07	0.06
CD (P=0.05)	0.24	0.20	0.16
Organic manure			
M_0 (Control)	4.87	4.96	4.92
M_1 (FYM 10 t ha^{-1})	6.76	7.35	7.05
M_2 (FYM 20 t ha^{-1})	6.92	7.63	7.27
SEm±	0.08	0.07	0.06
CD (P=0.05)	0.24	0.20	0.16
Bio-fertilizers			
B_0 (No-inoculation)	5.86	6.31	6.08
B_1 (PSB inoculation)	6.28	6.70	6.49
B_2 (*Azospirillum* inoculation)	6.41	6.93	6.67
SEm±	0.08	0.07	0.06
CD (P=0.05)	0.24	0.20	0.16

The total soluble solids (T.S.S.) of onion bulbs applied with FYM @ of 20 t ha^{-1} was recorded maximum 12.03%, 12.10% and 12.07% followed by FYM @ 10 t ha^{-1} 11.75% and 11.82%, in both the years 2015-16, 2016-17 and on pooled basis, respectively. Both the manure levels showed

statistically significant higher total soluble solids (T.S.S.) of onion bulbs than control. It was also found that there was 8.25% and 5.73% increase in total soluble solids (T.S.S.) of onion bulbs treated with FYM @ 20 t ha^{-1} and 10 t ha^{-1} as compared to control. Same trends have revealed in allyl propyl disulphide content of bulbs applied with FYM @ of 20 t ha^{-1} was recorded maximum 6.92, 7.63 and 7.27 mg 100 g^{-1} followed by FYM @ 10 t ha^{-1} 6.76 mg 100 g^{-1} and 7.35 mg 100 g^{-1} in both the years of 2015-16, 2016-17 and as well as on pooled basis, respectively. The result also indicated that allyl propyl disulphide content in onion bulbs in control was recorded minimum 4.87 mg 100 g^{-1}, 4.96 mg 100 g^{-1} and 4.92 mg 100^{-1} in both the years 2015-16, 2016-17 and as well as on pooled basis. Both the treatments showed statistically significant higher allyl propyl disulphide content in onion bulbs than control. It was also found that there was 47.76% and 43.29% increase in allyl propyl disulphide content in onion bulbs treated with FYM @ 20 t ha^{-1} and 10 t ha^{-1} as compared to control.The beneficial effect FYM in increasing the quality content of bulb and leaves might be attributed to direct supply of nutrients. Moreover, FYM after decomposition might have released macro and micro nutrients, which increases the availability of nutrients to the soil, plant system and thus increased the nutrient content in plants. The higher nutrient availability enhanced photosynthesis and their translocation to different plant parts resulting into higher concentration of nutrients. The nutrient content and other quality attributes were increased significantly with application of FYM. Similar findings have been earlier reported by Vachhain and Patel (1993) [20] and later on by Choudhary *et al*. (2013) [3], Meena *et al*. (2014) [10], Meena *et al*. (2015) [11].

The maximum Total Soluble Solid and Allyl propyl disulphide content in bulb were recorded by the use of *Azospirillum* and PSB inoculation and minimum in no inoculation samples.*Azospirillum* might have fixed higher amount of nitrogen in soil and made available to the plants resulted in better uptake of N by plants. The improvement in quality of bulb might have helped in increased photosynthetic rate and more photosynthesis mobilization. Similarly, quality attributes might have improved due to higher photosynthetic rate, better source sink relationship, better nutrients uptake, besides excellent physiological and biochemical activities. Similar results have been reported by Musmade and Konde (1987), Mahendran and Kumar (1996), Thilakavathy and Ramaswamy (1998) [18], Gowda *et al*. (2007) [6], Chattoo *et al*. (2007), Sharma (2014) [15] and Meena *et al*. (2015) [11].

Conclusion

In this study, the highest content of TSS and pungency were observed in manure @ 20 t ha^{-1} followed by 100% RD of NPK and Azospirillum. In arid region, the soil is less in nutrient and organic carbon content due to sandy in nature, high temperature, low vegetation and soil fauna etc. Therefore, we need to apply organic (FYM) and inorganic fertilizers along with biofertilizers at the optimum level to enhance the macro and micro nutrient content in the soil and can increased the onion production with the quality bulbs.

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