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Influence of gypsum on growth and biochemical quality in onion (*Allium cepa* L.)

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Abstract
Onion is one of the commercial vegetable crops of India. Gypsum has been recognized as an important nutrient for higher yield and quality of onion bulbs. A positive significant interaction was found between Ca and S; the presence of Ca+ ion facilitates S uptake and stimulate rate of photosynthesis resulting in batter yield. Field experiment was conducted to study the effect of gypsum on growth and yield in onion crop. Six treatments are allocated randomly with four replications using RBD. The results states that the treatment T_4 (NPK + 18% gypsum) performed better in terms of seed germination % (62.28%), plant height at 80 DAT (32.14 cm), No. of leaves per plant (11.65 cm), bulb diameter (4.62 cm), bulb weight at 100 DAT (113.63 cm), crop growth rate (70.03 g.m-2 T-), average dry weight 12.07(g), bulb protein content (1.6mg/g FW), bulb sulphur content (6.12ppm). Application of sulphur @ 45 kg per ha in form of gypsum may be recommended in onion crop for obtaining higher growth and yield in onion.

Keywords: Vegetable crop, gypsum, germination, growth, sulphur

Introduction
Gypsum is soft sulphate mineral composed to calcium sulfate dehydrate, with the chemical formula CaSO4.2H2O which is a major source of Calcium and S for the plant. As calcium increases nitrogen, potassium and phosphorous absorption in roots, stimulates photosynthesis, increases the plant size and improves fruit quality in various vegetables like onion, tomato etc (Pradhan *et al.*, 2015) [10]. Calcium increases ammonium, potassium and phosphorus absorption, and a positive significant interaction was found between Ca and S; with increase in level of calcium from in presence of various S levels stimulates photosynthesis, and increases the size of sellable plant parts (Aulakh and Dev 1978). It also makes the use of nitrogen more efficient, Ca+ increases photosynthesis and greater amounts of carbon dioxide are captured by the plant from the air, which increases the plant's organic building blocks. (Nasreen *et al.*, 2007) [6, 7].

Sulfur plays critical roles in the catalytic or electrochemical functions of the bio-molecules in cells (Saito, 2004) [12]. Sulfur is useful for the formation of amino acids, oligopeptides, chlorophyll, certain enzymes, vitamins and cofactors, proteins and oils, and a variety of secondary products in *Allium* (Leustek, 2002; Stewart, 2010) [4]. Sulphur has been recognized as an important nutrient value, flavors and pest and diseases, severe sulphur deficiency during onion bulb development has detrimental effect on yield quality of onion (Hore *et al.*, 2014).

Onion (*Allium cepa* L.) is one of the important cash vegetable crops grown throughout the world. Onion belongs to the family Alliaceae and is said to be native of Central Asia and Mediterranean region. Onions have been used as a condiment in the cuisines of ancient China, India, and Egypt for well over 4000 years (Alam *et al.*, 2007) [1]. Onion bulbs and greens both are rich in vitamin-C, potassium, dietary fiber, minerals and folic acid. Onion bulbs also contain calcium, iron and have a high protein quality and low sodium with no fat content. It is mainly used for cuisine, salad and culinary purpose. Onion has always held a place in folklore and folk medicine, but recently biochemists have revealed its anti-bacterial properties, particularly against *Helicobacter pylori*, the ulcer-forming microorganism (Singh 2008) [11]. The bulb is useful as diuretic and heart stimulant. India is being second largest producer still faces shortage in supply and demand for onion which results in high price rise situations during past few years. Further sulphur deficiency results in degradation of quality parameter such as pungenc. This is due to continuous use of S-free fertilizers and increasing cropping intensity with high yielding cultivars. Information about effect of sulphur application on uptake of nutrients in onion is rather limited (Pradhan *et al.*, 2015) [10].

Materials and Method

The field experiment on onion crop (*Allium cepa* L.) verities N-53 Dark red of was conducted during *Rabi* 2015-2016. The treatment consists of different dose of sulphur via gypsum @ (T_0- 0, T_1- 4.5%, T_2- 9%, T_3- 13.5%, T_4- 18%, T_5- 22%) by adopting RBD with four replications. And before transplanting first dose of treatment was applied at 30 DAT & 45 DAT. Plant were planted with standard spacing of 15 cm × 10 cm and observation recorded were determine plant height, No. of leaves, bulb diameter, chlorophyll "a", "b", Carotenoid, protein, sulphur). Further chl "a" "b" and Carotenoid leaf extract and protein, sulphur fresh bulb.

Results and Discussion

Plant height (cm): The plant height was maximum in T_4 (32.14 cm). While, minimum plant height was obtained in T_0 (26.51 cm).The plant height was recorded maximum under T_4 (18% gypsum recommended dose of fertilizer) Similar finding were also reported by (Meher *et al.,* 2016) [5] were plant height 56.9 cm repotted. (Tripathy *et al.,* 2013) [14] were plant height (54.51 cm) was significantly increases. The increase in plant height with the application of gypsum might be due to its role in the synthesis of. Chlorophyll further higher levels of S application increases uptake of nutrients which might have influenced the synthesis and translocation of stored materials. (Jaggi *et al.,* 2010). Number of leaves per plant: The maximum number of leaves per plant (table.1 Fig.2) was in T_4 (11.65). Whereas, minimum number of leaves/plant in T_0 (10.48). The 18% RDF were produced comparatively higher number of leaves as comparison to control. Similar results have been reported by (Meher *et al.,* 2016) [5] Number of leaves per plan 8.7 is repotted. (Nasreen 2007) [6, 7] Application of gypsum fertilizer promotes nutrients and their activity and also provide nutrients uptake in plant which helps to initiate various growth promoting activities, resulting vigorous growth of plants. The onion plants nourished with (N, P and K) and gypsum fertilizer gave maximum values in growth parameters, this boosted vegetative growth might be due to ensured higher number of green leaves. (Tripathi *et al.,* 2013) Bulb diameter (cm): The result indicated that the maximum bulb diameter was noted in T_4 (4.62 cm). Whereas, minimum bulb diameter was noted in T_2 (2.75cm). Significantly higher bulb diameter was recorded under 18% of gypsum RDF with combination of NPK substances. Similarly, increased bulb equatorial diameter (4.82) with the application of higher levels of gypsum was obtained by (Jaggi *et al.,* 2005) Significant increase in yield attributes like bulb polar diameter and equatorial diameter at higher levels of S application might be due to increase uptake of nutrients which might have influenced the synthesis and translocation of stored materials (Pradhan *et al*. 2015) [10] chlorophyll "a", "b" and Carotenoid: The result indicated that the maximum chlorophyll "a" was noted in T_5 (0.79mg/g FW), whereas, chlorophyll "a" was noted in T_0 (0.56mg/g FW). Significantly higher chlorophyll "a" was recorded under 22% of gypsum RDF with combination of NPK substances, maximum chlorophyll "b" was noted in T_4 (0.53mg/g FW), and minimum T_0 (0.45mg/g FW). Significantly higher chlorophyll "b" was recorded under 18% of gypsum RDF with combination of NPK substances and maximum total Carotenoid was noted in T_5 (0.64mg/g FW) and minimum Carotenoid was noted in T_0 (0.54mg/g FW). Significantly higher Carotenoid was recorded under 22% of gypsum RDF with combination of NPK substances, similar result found chlorophyll "a" was noted (1.09mg/g FW), chlorophyll "b" (0.78mg/g FW) and Carotenoid was noted (0.86mg/g FW) in response to gypsum and sulphur result were revaluated by (Navaldey 2014) [9] that high S fertilization increase Rubisco chlorophyll and protein content the important regulatory function of the calcium transport from the cytosol into the chloroplast illumination. Also calcium is transported along the electrochemical potential gradient from the cytosol into the stoma of the chloroplast. Leaf and Bulb protein content: The result indicated that the maximum leaf protein content was noted in T_5 (0.58mg/g FW), whereas minimum leaf protein content was noted in T_0 (0.23mg/g FW). Significantly higher protein content was recorded uznder 22% of gypsum RDF with combination of NPK substances and the maximum bulb protein content was noted in T_5 (1.15mg/g FW), Whereas, minimum bulb protein content was noted in T_0 (0.23mg/g FW). Significantly higher protein content was recorded under 22% of gypsum RDF with combination of NPK substances this might be due to under sulphur deficiency, shortage the sulphur- containing amino acid cysteine and methionine inhabit protein synthesis reported by (Mazhar *et al.,* 2011). Bulb sulphur content the result indicated that the maximum bulb sulphur content was noted in T_4 (7.74 ppm FW), followed by T_5 (6.12 ppm FW).Whereas, minimum bulb sulphur content was noted in T_0 (3.77ppm FW). Significantly higher sulphur content was recorded under18% of gypsum RDF with combination of NPK substances. Similarly result bulb sulphur content (4.50µmol g-1) by (Chattopadhyay *et al.,* 2015) [2] sulphur was added as CaSO4 may have been taken up increasing amount with increasing SO4-2 levels S containing amino acids whose production increase with increase in S and pyruvic acid content of bulb was due to increased uptake of S by crop due to its application to soil resulting in the increased synthesis of volatile sulphur compounds and production of more pungency in onion.

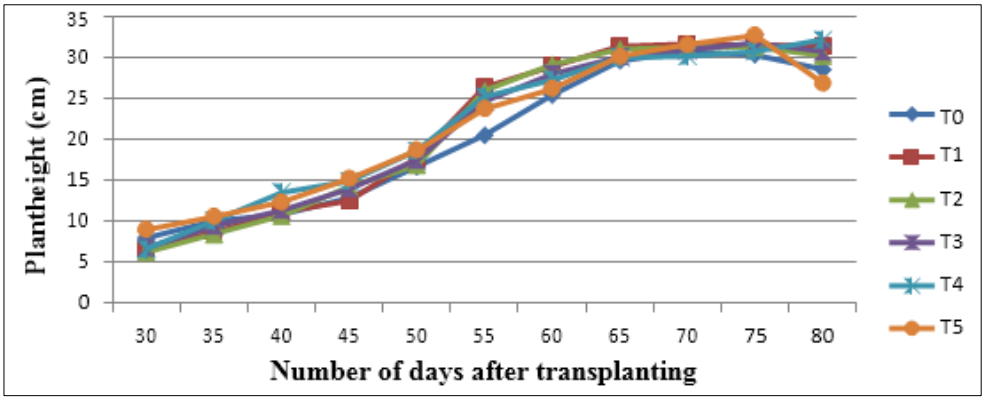

Fig 1: The Effect of different doses of gypsum on Plant height of onion.

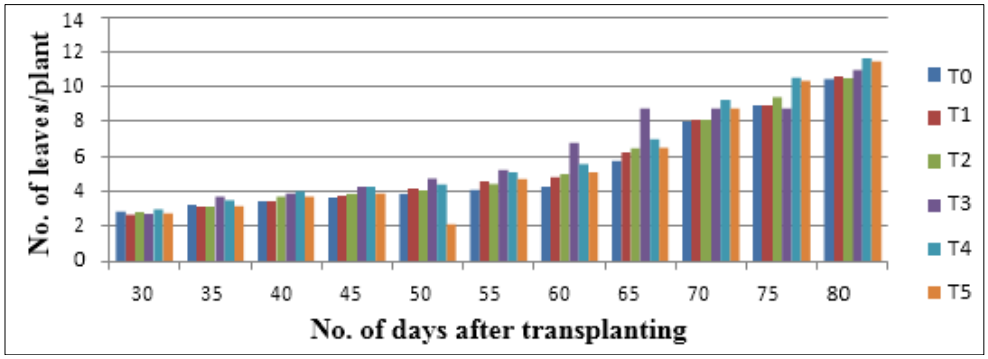

Fig 2: Effect of different doses of gypsum on Numbero fleaves of onion.

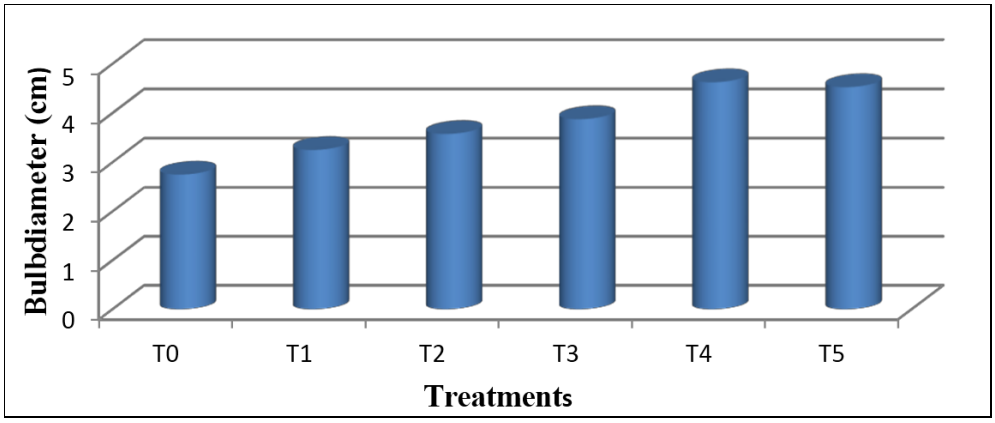

Fig 3: The Effect of different doses of gypsum on Bulb diameter (cm) of onion.

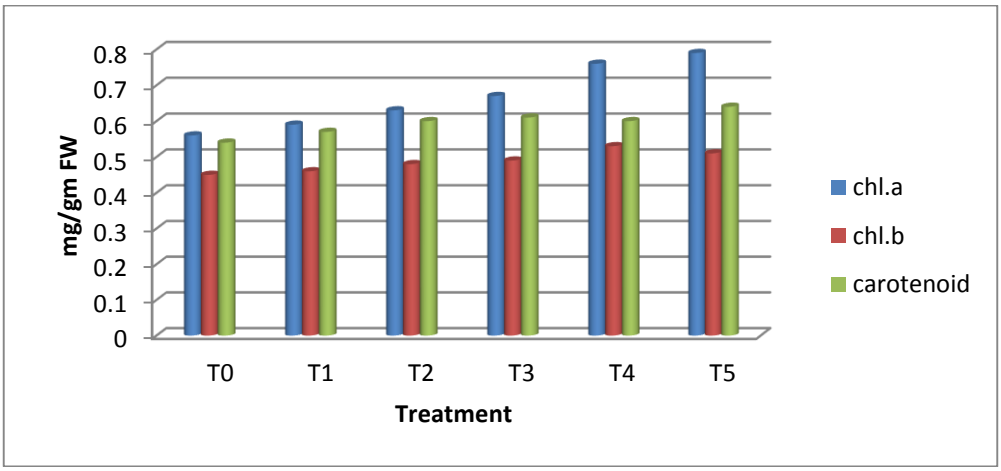

Fig 4: The Effect of different doses of gypsum on Chl"a", Chl"b"and Carotenoid content (mg/gFW) on onion.

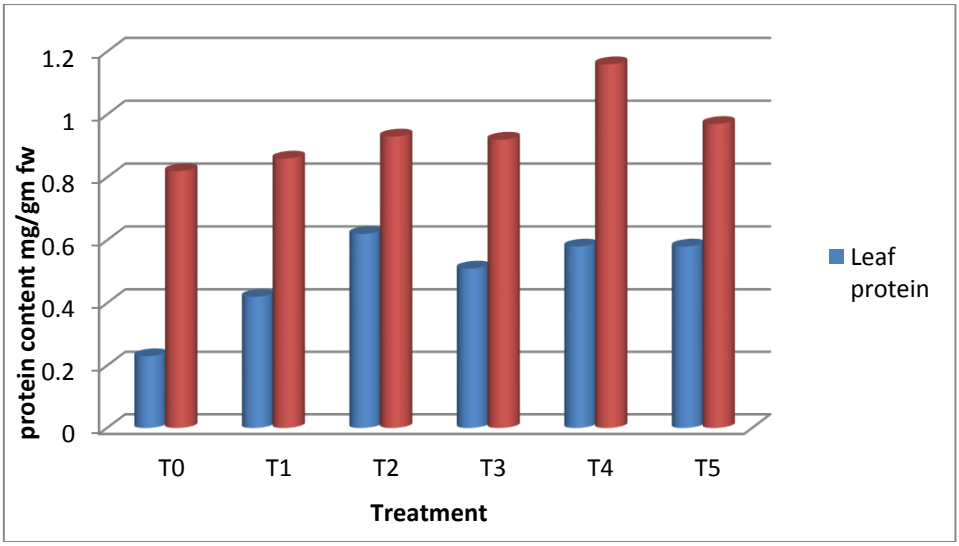

Fig 5: Effect of different dose of gypsum on leaf and bulb Protein content (mg/gFW) on onion.

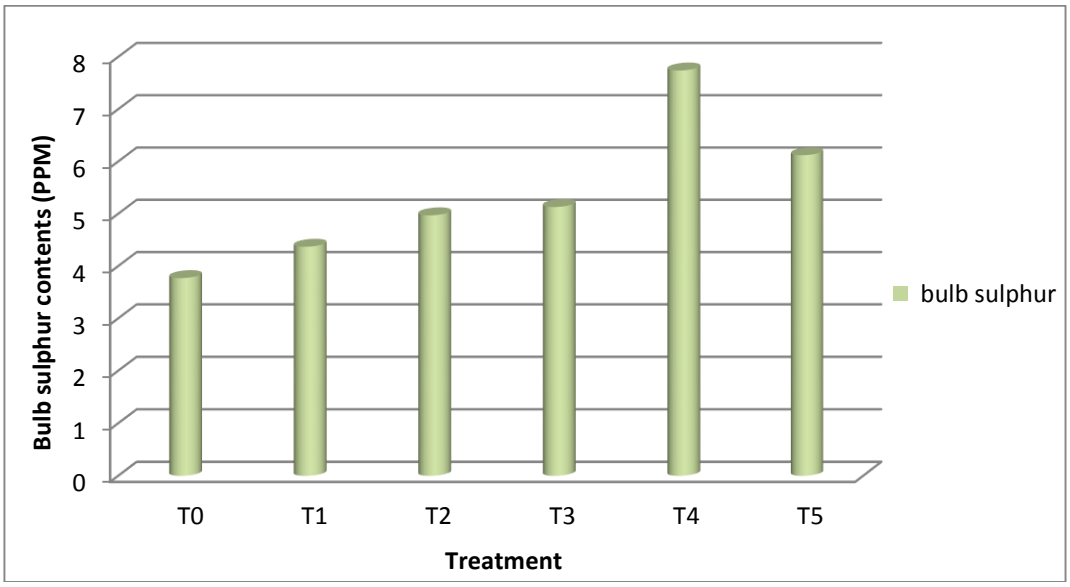

Fig 6: The effect of different doses of gypsum on bulb sulphur contents (ppm).

Table 1: The Effect of different doses of gypsum on vegetative growth parameter of onion.

Treatment	Plant height (cm)	No. of leaves (Plant^{-1})	Bulb diameter (cm)
T_0	26.51±0.66	10.480±0.03	2.75
T_1	31.4±1.12	10.65±0.04	3.25
T_2	30.17±1.7	10.54±0.34	3.57
T_3	30.69±2.1	10.97±0.19	3.87
T_4	32.14±0.4	11.65±0.05	4.62
T_5	28.86±1.4	11.470±0.05	4.52
	SE.D(±)0.9	SE.D(±)0.13	SE.D(±)0.16
	C.D(%)2.9	C.D(%)0.45	C.D(%)0.52

Table 2: The Effect of different dose of gypsum on Biochemical parameter of onion.

Treatment	Chl "a" (mg/gFW)	Chl"b" (mg/gFW)	Carotinoid (mg/gFW)	Leaf protein content(mg/gFW)	Bulb protein Content(mg/gFW)	Bulb Sulphur content(ppm)
T_0	0.56	0.45	0.54	0.23	0.82	3.77
T_1	0.59	0.46	0.57	0.42	0.86	4.37
T_2	0.63	0.48	0.60	0.62	0.93	4.97
T_3	0.67	0.49	0.61	0.51	0.92	5.13
T_4	0.76	**0.53**	0.60	**0.58**	**1.16**	**7.74**
T_5	**0.79**	0.51	**0.64**	0.58	0.97	6.12
	SED(±)1.90	0.01	0.01	0.01	SE.D(±).05	SE.D(±)0.16
	C.D4.06	0.04	0.06	0.03	C.D(%).11	C.D(%)0.52

Conclusions

Present investigation, it is concluded that gypsum play important role for increasing the growth and biochemical parameters treatment T_4 (RDF+75g 18%) is the superior to all other treatments application of gypsum improve pungency character positively. Application of *gypsum* also improved soil quality.

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