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Effect of PGR (Humex) on the Yield and Yield Components of Tomato (*Solanum lycopersicum* L.)

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Abstract

The experiment was conducted during rabi season 2018-2019 at Agricultural Research Station, On-Farm Research Division (OFRD), Bogura, to determine the effects of Plant Growth Regulator (PGR) (Humex) on the growth and yield of tomato. The experiment was arranged in a randomized complete block design (RCBD) with five treatments in three compacted replicates blocks. The treatments included T1=Recommended inorganic fertilizer + 4.16 kg Humex, T2=Recommended inorganic fertilizer + 8.33 kg Humex, T3=Recommended inorganic fertilizer + 12.5 kg Humex, T4=Recommended inorganic fertilizer + 16.66 kg Humex,and T5=Recommended inorganic fertilizer. The highest yield was observed in T4 (84.59 t ha^{-1}) due to more fruit and the highest weight of fruit per plant, which was statistically similar to all other treatments. The highest gross return was recorded in T4 (BDT. 676720 ha^{-1}), and the lowest was in T5 (BDT. 640160 ha^{-1}). The highest gross margin was found in T4 (BDT. 301455 ha^{-1}) and the lowest in T5 (BDT. 264895 ha^{-1}). This result indicated that humex can increase the yield of tomato.

Keywords: Plant Growth Regulator, yield, and economic return.

Introduction

Tomato (*Solanum lycopersicum* L.) is one of the most well-liked fruiting vegetable crops worldwide. It belongs to the family Solanaceae and is a self-pollinated crop. It is nutritious vegetables rich in vitamin A and C and widely cultivated and consumed in most parts of the country during winter season. Its food value is very rich because of its higher contents of vitamins A, B, and C and minerals like calcium, promoting good health (Wilcox *et al.*, 2003). It is cultivated worldwide due to its adaptability to a wide range of soil and climate (Ahmed, 1976). It is the most consumable vegetable crop after potato and sweet potato occupying the top of canned vegetables (Chowdhury, 1979). Tomato is considered a protective food because of its particular nutritional value. It provides essential nutrients such as lycopene, beta-carotene, flavonoids, vitamin C, and hydroxycinnamic acid derivatives. Furthermore, this crop has achieved tremendous popularity especially in recent years, with the discovery of lycopene's anti-oxidative activities

and anti-cancer functions (Wu *et al.*, 2011; Raiola *et al.*, 2014).

Plant growth regulators (PGRs) are essential for the growth and development of plants and play an important role in flowering, fruit setting, changes ripening, and physiochemical during storage. PGRs are extensively used in horticultural crops to enhance plant growth and improve yield by increasing fruit number, fruit set, and size. PGRs are used extensively in tomatoes to improve yield by improving fruit set, size, and number of fruits (Batlang, 2008; Serraniet *et al.*, 2007). It plays a key role in controlling internal mechanisms of plant growth by interacting with key metabolic processes such as, nucleic acid metabolism and protein synthesis. The useful effects of PGRs to increase the yield and quality of solanaceous and other vegetables have been reported by many workers. Such as in tomato, Phookan *et al.* (1991), Singh and Singh (1993), Singh and Singh (1996) and Singh and Lal (2002) have been reported their positive response. Root development, stem growth, blooming time or plant maturity can be stimulated subject to the usage conditions of growth regulators. Humex is a newly introduce PGR. It is the composition of humic acid. Humic Acid is a heterogeneous blend of many compounds, a mixture of faint aliphatic and aromatic organic acids not soluble in acidic water but soluble in alkaline water (Pettit, 2004). This affects plant growth and soil characteristics (Tan, 2003). Humex (the humic acid) is made for organic fertilization and is commercially produced. Its components enhance the soil fertility and the availability of nutrients, enhance plant growth, yield and reduce the harmful effect by various mechanisms within plants and soils (Unlu *et al.*, 2011; Moraditochaee, 2012). Considering these things, the present investigation was taken to evaluate the performance humex PGR on yield and yield components of tomato.

Materials and Methods

The experiment was conducted during rabi season 2018-2019 at Agricultural Research Station, OFRD, Bogura (Latitude: 24051'4.2948"N, Longitude: 89022'52.8492" E and Altitude: 29m) to find out the useful effects of PGR (Humex) on growth and yield of tomato. The land was medium high and the soil was sandy loam in texture which belongs to Agro Ecological Zone-03.

The experiment was arranged in a randomized complete block design (RCBD) with five treatments in three (03) compacted replicate blocks. The treatments included T1=Recommended inorganic fertilizer + 4.16 kg Humex, T2= Recommended inorganic fertilizer + 8.33 kg Humex, T3= Recommended inorganic fertilizer + 12.5 kg Humex, T4= Recommended inorganic fertilizer + 16.66 kg Humexand T5= Recommended inorganic fertilizer. The crop variety was BARI Tomato 15. Each plot measured 4m × 3m. Thirty days old seedlings were transplanted on 10 December, 2018 maintaining 60 × 50cm spacing. The crop was fertilized with recommended doses of fertilizers and manure at the rate of 207-50-130-20-3 kg/ha of NPKSZn along with cowdung 10 tha^{-1}. Cowdung was added during final land preparation. Half of the muriate of potash with full dose of all fertilizers was applied in the field during final land preparation except urea. Urea was applied in three split doses at 10 DAT, 25 DAT and 40DAT. Rest of muriate of potash was added with 2nd and 3rd split of Urea. PGR was applied @ 4.16 kg, 8.33 kg, 12.5 kg and 16.66kg ha^{-1} at one time. Imitaf and Autostin were applied as preventive. Secure and acrobat MZ was applied against late blight disease. The crop was irrigated thrice at 20 DAT, 35 DAT, and 60 DAT. The last harvest of the crops was done on 10 March 2019. At maturity, data on yield and yield contributing characters were taken and analyzed statistically by using MS Excel and 'R' software package (R Core Team, 2017). The production cost of tomato included costs of field preparation, seed, planting, irrigation, organic manure and synthetic fertilizer, plant protection chemicals and harvesting. Gross return under a treatment was calculated by multiplying the gross amount of crop produced by the farm-gate price. The gross margin was calculated by subtracting cost of production from the gross return (Ferdous *et al.*, 2018).

Results and Discussion

Yield contributing characters and yield

The results have been presented in Table 1. There was not significant difference among the treatments but numerically different in all treatments. The highest plant height was found in T4 (128.47 cm), which was statistically similar to all other treatments. The highest fruit $plant^{-1}$ was obtained from T4 (38.40), and the lowest was in T1(35.83). The highest weight of fruit $plant^{-1}$ T4 (2538 g) and the lowest from T5 (2400 g).

The highest yield was observed in T4 (84.59 t ha^{-1}) due to more fruit $plant^{-1}$ and the highest weight of fruit per plant, which was statistically similar with T3 and the lowest in T5 (80.02 t ha^{-1}).

Table 1. Yield and yield attributes of tomato as influenced by PGR **(**Humex) at BARI, Bogura during 2018-19.

Treatments	Plant height (cm)	No. of fruit $plant^{-1}$	Weight of fruit $plant^{-1}$ (g)	Yield (t ha^{-1})
T1	121.07	35.83	2466	82.57
T2	122.33	35.87	2488	82.93
T3	123.60	36.77	2517	83.90
T4	128.47	38.40	2538	84.59
T5	117.33	37.00	2400	80.02
CV (%)	7.50	7.93	8.06	7.06
LSD (0.05)	5.19	0.23	0.79	7.90

T1=Recommended inorganic fertilizer + 4.16 kg Humex, T2=Recommended inorganic fertilizer + 8.33 kg Humex, T3=Recommended inorganic fertilizer + 12.5 kg Humex,T4=Recommended inorganic fertilizer + 16.66 kg Humex,and T5=Recommended inorganic fertilizer.

Plant height of tomato increased with the application of plant growth regulators, which was revealed to be one of the yield contributing characters. This could be because the plant growth regulators Humex increased cell division with significant stem elongation, resulting in the most extended tomato plant. According to several reports, Humex increased the plant height of tomato (Kazemi, 2013, 2014; Farnia and Moradi, 2015), weight of tomato (Abdel-Monaim *et al.*, 2012), and number of flowers of tomato (Kazemi, 2014), as well as fruit yield of tomato (Yildirim, 2007) and total yield of tomato (Abdel-Monaim *et al.*, 2012; Aman and Rab, 2013; Kazemi, 2013, 2014; Asri *et al.*, 2015; Farnia and Moradi, 2015). The reasons for this increase are interconnected. Several studies have also shown that the effect of stressors on plants can be reduced by Humex (Unlu *et al.*, 2011; Moraditochaee, 2012) and in soils (Baldotto et al. 2010). The same trend of the results was reported on tomato using plant growth regulators (Shittu and Adeleke, 1999; Wu *et al.*, 1983). Stimulating root growth and increasing water and the intake of vegetable plants, Humex plays significant roles in plants (Cimrin & Yil-maz, 2005). It may also affect cell division (Chen *et al.*, 2004) and improve the synthesis of proteins (El-Ghamry *et al.*, 2009; Patil, 2010), which enhances the overall protein content of plants (Nardi *et al.*, 2002). Humex also provides growth controls in plant hormone levels to regulate and control (Nardi *et al.*, 2002) and promote plants' enzyme and hormone production (Sarir *et al.*, 2005). It also enhances enzyme catalysis and restorative processes, and photosynthesis (Nardi *et al.*, 2002). These mechanisms also refer to Humex's direct influence on plants and their influence on soil fertility (Fahramand *et al.*, 2014). It occurs through the enhancement of soil physical (Varanini and Pin-ton, 1995), chemical, and biological properties (Keeling *et al.*, 2003; Mikkelsen, 2005) that augment water holding capacity (McDonnell *et al.*, 2001). It is also a good energy source for useful soil organisms (Pettit, 2004) and stimulates activities of the enzyme (Burkowska and Donderski, 2007). Humex is used for soil reclamation purposes (Ameri and Tehranifar, 2012).

Table 2. Cost and return analysis of tomato as influenced by PGR **(**Humex) at OFRD, BARI, Bogura during 2018-19.

Treatments	Yield (tha^{-1})	Total variable cost (BDT. ha^{-1})	Gross return (BDT. ha^{-1})	Gross margin (BDT. ha^{-1})
T1	82.57	375265	660560	285295
T2	82.93	375265	663440	288175
T3	83.90	375265	671200	295935
T4	84.59	375265	676720	301455
T5	80.02	375265	640160	264895

T1=Recommended inorganic fertilizer + 4.16 kg Humex, T2=Recommended inorganic fertilizer + 8.33 kg Humex, T3=Recommended inorganic fertilizer + 12.5 kg Humex, T4=Recommended inorganic fertilizer + 16.66 kg Humex,and T5=Recommended inorganic fertilizer.

Price (BDT. kg^{-1}): Urea- 16, TSP- 25, MoP- 15, Gypsum- 9, Zinc Sulphate- 130, Boric acid- 140, Tomato- 8.
*Without PGR price

Cost and return analysis

From cost and return analysis the highest gross return was recorded in T4 (BDT. 676720 ha^{-1}) and lowest was in T5 (BDT. 640160 ha^{-1}). The highest gross

margin was found in T4 (BDT. 301455 ha^{-1}) and lowest in T5 (BDT. 264895 ha^{-1}).

Conclusion

From the study, it is evident that Plant growth regulator (Humex) has a significant positive effect on tomato yield. It can be concluded that the addition of Humex to the soil for the cultivation of tomatoes climate can increase the yield by 3.5 to 14 kg ha^{-1} application rate. So this PGR (Humex) can be recommended for the tomato production.

Conflict of interest

There is no conflict of interest among the authors.

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