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Effect of Transplanting Dates and Nitrogen Levels on Yield Attributes of Tomato in Temperate Region of Kashmir

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ABSTRACT: A field investigation was undertaken during kharif seasons of 2020 and 2021 at Vegetable Experimental Farm of Division of Vegetable Science, SKUAST-Kashmir, Shalimar with an objective to study the effect of different dates of planting and different levels of nitrogen in Kashmir region. The experiment was setup in 3×5 factorial design with 3 dates of transplanting (30th April, 14th May and 28th May) as main plot treatments and 5 levels of nitrogen as sub plot treatments (80, 100, 120 140 and 160 kg ha^{-1}) during two consecutive Kharif seasons of 2020 and 2021. The experimental results showed that different planting dates and nitrogen levels showed significant influence on reproductive characters of tomato including fruit yield. The pooled data regarding yield attributing parameters *viz.,* fruit length, fruit diameter, number of fruits per plant, average fruit weight, fruit yield was found to be maximum when crop was transplanted on 14th May during both consecutive seasons recording the values of 6.52cm, 4.50cm, 18.98, 41.62 g and 295.72 q ha^{-1} respectively with nitrogen application of 100kg per ha recording the values of 6.80cm for fruit length, 4.71 cm for fruit diameter, 19.51 for number of fruits per plant, 42.28 g for average fruit weight and 282.11 q ha^{-1} for fruit yield which was significantly superior to all other treatments but statistically at par with 120 kg nitrogen application during both the seasons. Despite the fact that tomato production appears to be increasing over the years, yield continues to fall due to poor cultural practices, particularly the use of N doses and transplanting dates. If planting time coincides with optimal ecological conditions for better germination, it may result in better plant development and, as a result, it may lead to a higher yield of high-quality fruits. As a result, increase in yield through N dose manipulation and determining the optimal transplanting date is critical so that the plants are exposed to favourable environmental conditions during their growth period for fruit set and higher total yield. In light of the foregoing facts, a site-specific demonstrative trial was conducted at the SKUAST-K experimental field in Shalimar.

Keywords: Transplanting dates, Nitrogen, main plot, reproductive characters, fruit length, fruit diameter, fruit yield.

INTRODUCTION

Tomato (*Solanum lycopersicum* L.) with chromosome number 2n =24 belongs to the family Solanaceae. It is an important warm season, self-pollinated vegetable crop cultivated both for fresh and processing market (Nwosu *et al*., 2014). It is widely cultivated in tropical, subtropical and temperate climates and ranks second next to potato in terms of world vegetable production. In Jammu Kashmir, it covers an area of 2.28 thousand hectares with an annual production of 52.96 thousand MT (Anonymous, 2019). Tomato is grown as an annual crop. It has taproot and growth habit of plant is determinate, semi-determinate and indeterminate (Reddy *et al*., 2013). Tomato requires warm season for successful cultivation and it is susceptible to cold winds and frost. Tomato is universally treated as Protective Food since it is a rich source of vitamins, minerals organic acids (Akinfasoye *et al*., 2011) and antioxidants *viz*., lycopene and beta-carotene (Kaur *et al*., 2013).

Tomato is always in great demand to meet the requirement of culinary and processing industry. Considering the demand, productivity of tomato need to be boosted. Even though tomato production seems to be on the increase over the years, yield continue to fall due to poor cultural practices especially the practice of N doses as well as transplanting dates. Nitrogen has the positive response (Gasim, 2001) and essential for building up protoplasm and protein, which induce cell division and initial meristematic activity when applied in optimum quantity. Nitrogen (N) occupies a conspicuous place in plant metabolism system. All vital processes in plants are associated with protein, of which nitrogen is an essential constituent. Consequently to get more crop production, nitrogen application is indispensable and unavoidable. Nitrogen plays a key role in agriculture by increasing of crop yield (Massignam *et al*., 2009). In addition, it is necessary for the synthesis of chlorophyll and photosynthesis (Bhuvanaswr *et al*., 2018). Nitrogen stands out among the main nutrients related to the increase in yield and for playing a fundamental role in crop yield and growth (Aminifard *et al*., 2010). It has pronounced effect on yield and quality of tomato (Xin *et al*., 1997). It also promotes vegetative growth, flowering and fruit set of tomato (Bose and Som 1990). One of the most crucial elements that significantly affects tomato development and production is the timing of planting. Due to variable climatic circumstances at various phases of the crop, there is a wide range of planting times that may impact its yield and quality. Plant development may be improved if planting time coincides with optimum ecological conditions would promote better germination, which might result in a higher yield of fruits with good quality. Consequently, it is crucial to increase yield by adjusting N dosages and determining the best time to transplant plants so that they are exposed to favourable climatic conditions for fruit set and greater overall output while they are growing. Furthermore, it has been observed that global climate change is expected to affect agricultural and horticultural crops through its direct and indirect effects. Rise in temperature will reduce crop duration, increase the respiration rate, alter photosynthate partitioning to economic product, alter phenology, particularly flowering, fruiting and reduced chilling accumulation and hasten senescence, fruit ripening and maturity. The emphasis should be on development of production systems for improved water use efficiency and to adapt to the hot and dry conditions. Strategies like changing sowing or transplanting dates in order to combat the likely increase in temperature and water stress periods during the crop growing season. Nitrogen (N) availability is the major limiting factor for increasing productivity of agricultural systems. Judicious application of nitrogen (N) to crops and cropping systems, through N fertilizers, is thus one of the important elements for producing adequate food to meet the demand of growing human population. Adequate nitrogen availability throughout the crop growth and development can ensure high yield and productivity. Deficiency of N limits crop growth; on the other hand, excess N is mostly lost to the environment resulting in pollution. There is often a huge disparity between N supply and demand in farming systems. Efficient use of N is thus crucial for enhancing productivity and profitability of the cropping system as well as to decrease the risk of N loss to the environment. Since, very little information is available regarding the effect of optimum time of transplanting in conjunction with nitrogen fertilizer on growth and yield of tomato under temperate conditions of Kashmir conditions.

MATERIAL AND METHODS

The experiment was laid out for two consecutive years of 2020 and 2021 during Kharif seasons at Experimental Field of Division of Vegetable Science, Sher-e-Kashmir University of Agricultural Sciences and Technology, Shalimar, Kashmir. The experiment was carried out with 3 dates of transplanting (30th April, 14th May and 28th May) as main plot treatments and 5 levels of nitrogen as sub plot treatments (80, 100, 120 140 and 160 kg ha^{-1}) in a 3×5 factorial design. Forty five (45) plots of 3.24 m^2 size were prepared as per layout specification to accommodate 12 plants plot^{-1}. Recommended dose of Phosphorus and Potassium (90:60 kg ha^{-1}) was provided through diammonium phosphate and muriate of potash. The source of nitrogen in the experiment was urea (46%), which was applied which was applied as per the treatments in three split doses i.e. 1/3 of nitrogen was applied as basal dose at the time of transplantation and the remaining two after transplantation before flowering at ten days interval A few gap filling was done by healthy plants whenever it was required. Irrigation along with other intercultural operations and plant protection measures were taken as and when necessary. Data were collected on yield and its attributing parameters *viz.,* fruit length, fruit diameter , number of fruits per plant , average fruit weight and fruit yield and analyzed statistically. The length of fruit was measured from the neck of the fruit to the bottom of five selected marketable fruits from each treatment and their average was taken as the length of fruit. Diameter of fruit was measured at the middle portion of five selected marketable fruits from each plot with a vernier calliper at harvest and the average was calculated and expressed in centimeter. Total number of fruits harvested at different pickings from five selected plants in each treatment was added and average was calculated to work out fruit number per plot. Fresh weight of tomato fruits from five selected plants from each plot were weighed at harvesting stage and their average was calculated and expressed in grams. The yield plot^{-1} (kg) was converted into q ha^{-1} for each treatment. Data collected were subjected to analysis of variance (ANOVA).

RESULTS AND DISCUSSIONS

Combined analysis of variance indicated that interactions between nitrogen levels, transplanting dates on yield attributing parameters had statistical significant differences. Pooled data revealed that yield and yield attributing attributes were significantly affected by different transplanting dates and different levels of nitrogen. It is evident from pooled data that maximum fruit length (6.52 cm) , fruit diameter (4.50 cm), no. of fruits per plant (18.98), average fruit weight (41.62 g), fruit yield per ha (295.72 q) was observed when crop was transplanted on 14th May during both Kharif seasons. According to Singh and Tripanthy (1995); Hossain *et al.* (2014) another reason could be because of the favourable climatic conditions that prevailed, notably the ideal daytime and nighttime temperatures during the development of the fruit and at the time of fruit setting, which led to increased photosynthesis and assimilate mobilisation. The current results trend is consistent with those of Islam *et al.* (2017).

Furthermore, data indicated that the maximum fruit length (6.80 cm), fruit diameter (4.71 cm), no. of fruits per plant (19.51), average fruit weight (42.28 g). Fruit yield per ha (282.11 q) was observed when crop was fertilised with 100 kg ha^{-1} (N_2 - 100kg N ha^{-1}) which was statistically at par with 120kg N ha^{-1} recording the values of 6.67 cm for fruit length, 4.57 cm for fruit diameter, 19.08 for number of fruits per plant, average fruit weight of 41.71 g and 280.90q yield per heactare. It might be due to vigour of plant by the uptake and utilized soil nutrients for the vegetative and reproductive growth. Another possible reason may be due to the increment in supply of essential nutrients to plant, their availability, mobilization and influx into the plant tissues increased and by this way improved numbers of flower cluster^{-1} and fruit size in terms of length and diameter which ultimately increased the yield (Shukla *et al.,* 2009). The increased fruit weight might be due to optimum supply of nitrogen all over the growing season which encouraged blooming and fruiting and supply of food material which enhanced fruit weight and fruit yield per plant (Rabindra and Srivastava 2006). Furthermore, the increase in yield might be due to more carbohydrate production and assimilation in fruit by the effect of nitrogen, phosphorus and potassium reported by Bidari and Hebsur (2011); Ahmad and Butt (1999) in tomato, Baloch *et al.* (2014) in radish. The positive response shown by yield. Parameters to N could be directly linked to the well-developed photosynthetic surfaces and increased physiological activities leading to more assimilates being produced and subsequently translocation of assimilates and utilized for fast fruit development. It was also reported by Aminifard *et al.* (2012) that nitrogen stimulated and enhanced the reproductive growth that were in agreement with findings of Satpal and Saimbhi (2003); Nawaz *et al.* (2012); Kumar *et al.* (2013); Hozhbryan (2013) in tomato. The sufficient supply of the three major nutrients nitrogen, phosphorus and potassium is anticipated to regulate plant physiological functions and morphological responses favorably (Shree *et al.* 2014). Pooled data also revealed that the maximum fruit length (7.09 cm), fruit diameter (4.96 cm), no. of fruits per plant (20.89), average fruit weight (43.56 g) was observed with the treatment combination of P_2N_2 (14th May and 100 kg N ha^{-1}). Significant effect of the interaction between planting dates and nitrogen fertilization levels was observed due to the fact that crops received optimal nutrition with suitable environmental conditions i.e. superiority of these factors for yield attributing parameters as reported by Abdul-elah Alsadi *et al.* (2021). Another possible reason might be that the interaction of N and transplanting date was synergistic at the moderate dose but antagonistic at higher dose as reported by Islam *et al.* (2008).

Table 1: Effect of transplanting dates and Nitrogen levels on fruit length (cm) in tomato.

	Pooled data of fruit length (2020-2021)			
Transplanting Dates / Nitrogen Levels	**P_1 (30th April)**	**P_2 (14th May)**	**P_3 (28th May)**	**Mean**
80 kg ha^{-1} (N_1)	5.51	6.66	6.20	6.12
100 kg ha^{-1} (N_2)	6.47	7.09	6.85	**6.80**
120 kg ha^{-1} (N_3)	6.28	7.01	6.74	6.67
140 kg ha^{-1} (N_4)	5.05	6.22	5.66	5.64
160 kg ha^{-1} (N_5)	4.80	5.63	5.04	5.15
	5.62	**6.52**	6.09	
	C.D (p≤0.05)		**S.E(d)**	
P	**0.10**		**0.05**	
N	**0.13**		**0.06**	
P × N	**0.23**		**0.12**	

Table 2: Effect of transplanting dates and Nitrogen levels on fruit diameter (cm) in tomato.

Transplanting Dates / Nitrogen Levels	Pooled data of fruit diameter (2020-2021)			
	P_1 (30th April)	**P_2 (14th May)**	**P_3 (28th May)**	**Mean**
80 kg ha^{-1} (N_1)	3.60	4.64	4.32	4.18
100 kg ha^{-1} (N_2)	4.46	4.96	4.71	**4.71**
120 kg ha^{-1} (N_3)	4.25	4.90	4.57	4.57
140 kg ha^{-1} (N_4)	3.35	4.39	3.65	3.79
160 kg ha^{-1} (N_5)	3.10	3.62	3.40	3.37
	3.75	**4.50**	4.13	
	C.D (p≤0.05)		**S.E(d)**	
P	**0.11**		**0.05**	
N	**0.12**		**0.06**	
P × N	**0.23**		**0.11**	

Table 3: Effect of transplanting dates and Nitrogen levels on no. of fruits per plant in tomato.

Transplanting Dates / Nitrogen Levels	Pooled data of no. of fruits per plant (2020-2021)			
	P_1 (30th April)	**P_2 (14th May)**	**P_3 (28th May)**	**Mean**
80 kg ha^{-1} (N_1)	15.71	18.77	17.25	17.24
100 kg ha^{-1} (N_2)	18.03	20.89	19.61	**19.51**
120 kg ha^{-1} (N_3)	17.47	20.61	19.18	19.08
140 kg ha^{-1} (N_4)	14.56	17.85	16.25	`16.22
160 kg ha^{-1} (N_5)	13.43	16.81	15.01	15.08
	15.84	**18.98**	17.46	
	C.D (p≤0.05)		**S.E(d)**	
P	**0.35**		**0.17**	
N	**0.54**		**0.27**	
P × N	**0.89**		**0.44**	

Table 4: Effect of transplanting dates and Nitrogen levels on average fruit weight (g) in tomato.

Transplanting Dates / Nitrogen Levels	Pooled data of average fruit weight (2020-2021)			
	P_1 (30th April)	**P_2 (14th May)**	**P_3 (28th May)**	**Mean**
80 kg ha^{-1} (N_1)	39.02	41.65	40.34	40.33
100 kg ha^{-1} (N_2)	40.80	43.56	42.48	**42.28**
120 kg ha^{-1} (N_3)	40.05	43.05	42.03	41.71
140 kg ha^{-1} (N_4)	37.46	40.58	39.03	39.02
160 kg ha^{-1} (N_5)	36.14	39.49	37.75	37.79
	38.65	**41.62**	40.32	
	C.D (p≤0.05)		**S.E(d)**	
P	**0.42**		**0.21**	
N	**0.59**		**0.29**	
P× N	**1.01**		**0.50**	

Table 5: Effect of transplanting dates and Nitrogen levels on fruit yield per ha (q) in tomato.

Transplanting Dates / Nitrogen Levels	Pooled data of fruit yield (2020-2021)			
	P_1 (30th April)	**P_2 (14th May)**	**P_3 (28th May)**	**Mean**
80 kg ha^{-1} (N_1)	240.74	292.27	281.03	271.35
100 kg ha^{-1} (N_2)	251.02	307.77	287.53	**282.11**
120 kg ha^{-1} (N_3)	249.02	303.39	290.30	280.90
140 kg ha^{-1} (N_4)	233.99	291.35	277.49	267.61
160 kg ha^{-1} (N_5)	232.02	283.83	272.35	262.73
	241.36	**295.72**	281.74	
	C.D (p≤0.05)		**S.E(d)**	
P	**3.56**		**1.78**	
N	**4.60**		**2.30**	
P × N	**7.98**		**3.99**	

CONCLUSIONS

It can be concluded that yield attributes were improved when the crop was transplanted on 14th May with application of 100kg of nitrogen per ha which was statistically at par with 120 kg N per ha during both the seasons. Suitable N fertilizer rate (NFR) and ideal planting date (PD) increased and improved source-to-sink relationship and dry matter accumulation, which is a component for increasing the fruit yield and profitability of the crop. Agronomic adjustment in N fertilization and PD would enhance resource use efficiency.

FUTURE SCOPE

If planting time coincides with optimum cultural practices, it may lead to better development of plants and ultimately higher yield of good quality fruits. Therefore, the improvement of yield through manipulation of N doses and finding out optimum transplanting date is essential so that the plants may be exposed to conducive environmental conditions during their growth period for fruit set and higher total yield.

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Conflict of Interest. None.

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