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Shoot Pruning on Fruit and Seed Production of Two Winter Tomato Varieties

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Abstract

This study was aimed to evaluate the effect of different pruning systems on the production of tomato (*Lycopersicon esculentum* Mill.) during winter in Bangladesh. Plants were pruned differently, such as, one shoot (P_1), two shoot (P_2), three shoot (P_3) with normal pruning (P_0) as a check. We used two tomato varieties and these were BARI Tomato 2 (V_1) and BARI Tomato 15 (V_2). We designed the experiments in complete randomized block design with three replicates. We didn't found any significant difference for days to 50% flowering, number of fruits/plant, single fruit weight and fruit yield/plant for the pruning treatment irrespective to the varieties. In combination of stem pruning and variety, we found that stem pruning slightly decrease the yield of both tomato varieties. Two shoot pruning (P_2) showed highest seed yield (14.5 g/plant; 49.6 kg/ha) and viability (85.2%). The highest seed yield was found from P_0V_1 (60.2 kg/ha), whereas the lowest (34.7 kg) from P_0V_2. The highest viability was found from P_1V_1 and P_3V_3 (99.0%) and the lowest viability (3.3%) recorded from P_1V_2. Both varieties performed differently to the different stem pruning. From the result of the current study, at least one/two stem pruning can be suggested for the seed production of tomato.

Keywords: *Lycopersicon esculentum; Shoot; Pruning; Fruit and Seed*

Abbreviation

HRC: Horticulture Research Centre; BARI: Bangladesh Agricultural Research Institute; BER: Blossom-End Rot; FC: Fruit Cracking; RCBD: Complete Randomized Block Design; DAT: Days After Transplanting; LSD: Least Significant Difference

Introduction

Tomato (*Lycopersicum esculentum* Mill.) is one of the most important vegetable throughout the world as well as in Bangladesh. The total tomato production exceeds all other crops (exception of the potato and sweet potato) [1]. It is used as multi-purpose, both in raw or processed forms. Irrespective to the economical class, Bangladeshis preferred it equally. Tomatoes are good source of minerals, vitamins [2,3] and anti-oxidant [4]. 40% vitamin C and 20% vitamin A of the recommended daily allowance can be fulfilled through the consumption of single ripe tomato [5]. It has the first preference with high value in vegetable market of Bangladesh, which motivates the farmers to cultivate more tomato. Despite the total cultivated area and production have increased gradually over the years, but the productivity is still low (6.46 t/ha) compared to the average yield of the world (26.29 t/ha) [6]. The annual tomato production in Bangladesh is about 167000 metric tons [7] and demands for vegetable seeds are 2700 tones while supply are 791.2 tons per year (63.2 tones for government sectors and 728 tones for private sectors, respectively) in Bangladesh [8]. Bangladeshi growers faced several problems on high yield with good quality tomato production. Several factors are responsible to the high yield and quality tomato production; and among these factors, some are plant population [9,10], stem pruning and cultivar selection [11]. Temporarily unfavorable climatic conditions [12,13], high

insect pest infestation and viral diseases [14,15] and fungal diseases [16] cause tomato much lower fruit yield in tropical and subtropical areas than that of temperate climates [17,18]. The physiological disorders such as BER and FC [13,19] are also responsible for the reduction of fruit quality and marketable yields as well [12,13,19,20]. BER and FC might also be influenced by source-sink relationships [21]. Tomato yield significantly decrease in the plants with side shoots [22]. Pruning facilitates the efficiency of photosynthesis and minimizes the diseases risk. A proper pruning system is important to balance the relationship between source-sink and carbon-nitrogen ratio [23]. The number of stems in tomato plant can affect to the development of fruit number [23] through the regulation of the N-CHO [24]. Stem pruning are essential for better yield and quality of tomatoes [9,17,25,26]. It can reduce the pest incidence [27,28], thereby increase yields. Tomato plant can be cultivated with one or two stems [12,15,22,29] for the increase of fruit yield. It was theorized that fruit and seed production of tomato can be increased in Bangladesh through pruning. Concerning the above mentioned theory, the aim of this study was to determine the effects of stem pruning on the fruit and seed production of two tomato varieties under the condition of Bangladesh.

Materials and Methods

The experiment was conducted at Olericulture Division, HRC, Bangladesh in 2014 - 2015 winter season (Mid October to mid-April). Plants were pruned the at four different pruning stages [No pruning as control (P_0), one shoot (P_1), two shoot (P_2), and three shoot (P_3)] to BARI Tomato 2 (V_1) and BARI Tomato 15 (V_2) varieties. The seeds were sown in the on October 20, and seedlings were transplanted in the main plot on November 19, 2014. The experiment was designed in RCBD with three replications. The plot size was 4.8 x 1 m^2 with 60 x 40 cm^2 spacing. Land was fertilized with cow dung, N, P, K, S, Zn and B @ 1000, 248, 88, 123, 21, 4.9 and 1.7 kg/ha respectively. Half of the cow dung, entire P, S, Zn, B and 1/3rd of K were applied as basal dose during final land preparation. The remaining cow dung was applied in pits while K in two equal installments as split at 15 and 30 DAT. The entire urea fertilizers were applied at three equal installments at 15, 30 and 45 DAT. Irrigation, weeding, other intercultural operation and plant protections measures were taken timely. Data were collected on days to 50% flowering, individual fruit weight, fruit yield, number of seeds, seed yield, seed viability, 1000-seed weight, and percent of filled seed. Seed viability was determined by the Top of Paper Method [30].

The collected data were analyzed using a MSTAT-C package computer program. The analysis of variance was performed and means were compared by LSD test at 5% level of significance [31].

Results and Discussion

Fruit production characteristics

Days to 50% flowering and number of fruits: It was not found any significant effect on days to 50% flowering through pruning and variety (Table 1 and Table 2). Pruning had not any significant effect on number of fruits per plant but pruning-variety combination showed significant effect (Table 1). The highest number of fruit was found from P_2 (32.5/plant) followed by P_0 (32.2/plant), while the lowest from P_1 (31.0/plant) (Table 1). Regarding combine effect, it was found the highest number of fruit from both P_0V_1 and P_3V_1 (35.0/plant) (Table 2).

Treatments	Days to 50% flowering	Fruit			
		Number/plant	Single wt. (g)	Yield (kg/plant)	Calculated yield (t/ha)
P_0	51.3^a ± 1.3	32.2^a ± 1.1	70.2^a ± 1.9	2.2^a ± 0.2	76.9^a ± 3.6
P_1	51.3^a ± 1.1	31.0^a ± 1.7	67.2^{ab} ± 1.6	2.1^a ± 0.1	75.8^a ± 4.1
P_2	51.3^a ± 1.6	32.5^a ± 1.3	66.5^{ab} ± 1.6	2.2^a ± 0.2	76.4^a ± 4.3
P_3	51.3^a ± 0.9	32.0^a ± 1.2	64.5^b ± 1.2	2.1^a ± 0.4	75.3^a ± 3.9
LSD(0.05)	0.9	3.4	4.5	0.2	7.3
CV (%)	1.0	6.2	3.8	5.9	5.6

Table 1: *Effect of pruning on yield contributing characters and yield of tomato.*

Note: *Values are means of three replicates with standard error; values in a column with having similar and dissimilar superscript letter(s) are statistically similar ($p > 0.05$) and different ($p < 0.05$) respectively; P_0: Control; P_1: One Shoot; P_2: Two Shoot; P_3: Three Shoot*

Treatments	Days to 50% flowering	Fruit			
		Number/plant	Single wt. (g)	Yield/plant	Yield/ha
P_0V_1	$50.3^{b} \pm 1.4$	$35.0^{a} \pm 1.1$	$77.3^{a} \pm 2.1$	$2.6^{a} \pm 0.04$	$86.1^{a} \pm 3.1$
P_1V_1	$50.3^{b} \pm 1.7$	$32.7^{ab} \pm 1.2$	$72.1^{b} \pm 2.4$	$2.3^{bc} \pm 0.02$	$78.0^{bc} \pm 2.6$
P_2V_1	$50.3^{b} \pm 1.2$	$34.7^{a} \pm 1.1$	$70.1^{bc} \pm 1.8$	$2.2^{c} \pm 0.05$	$75.6^{cd} \pm 2.9$
P_3V_1	$50.3^{b} \pm 1.5$	$35.0^{a} \pm 1.0$	$62.9^{d} \pm 1.7$	$2.5^{ab} \pm 0.09$	$84.1^{a} \pm 3.3$
P_0V_2	$52.3^{a} \pm 1.6$	$29.3^{bc} \pm 0.8$	$63.2^{d} \pm 2.5$	$1.9^{d} \pm 0.05$	$65.0^{e} \pm 2.8$
P_1V_2	$52.3^{a} \pm 1.3$	$29.3^{bc} \pm 1.1$	$62.3^{d} \pm 2.0$	$1.9^{d} \pm 0.03$	$65.3^{e} \pm 3.0$
P_2V_2	$52.3^{a} \pm 1.4$	$30.3^{bc} \pm 1.0$	$62.2^{d} \pm 2.2$	$1.9^{d} \pm 0.01$	$66.0^{e} \pm 3.3$
P_3V_2	$52.3^{a} \pm 1.5$	$29.0^{c} \pm 0.9$	$66.1^{cd} \pm 2.1$	$2.0^{d} \pm 0.06$	$69.5^{de} \pm 3.6$
LSD(0.05)	0.9	3.4	4.5	0.2	7.3
CV (%)	1.0	6.2	3.8	5.9	5.6

Table 2: *Effect of pruning-variety combinations on yield contributing characters and yield of tomato.*

Note: *Values are means of three replicates with standard error; values in a column with having similar and dissimilar superscript letter(s) are statistically similar (p>0.05) and different (p<0.05) respectively;*

P_0: Control, P_1: one shoot, P_2: two shoot, P_3: three shoot; V_1: BARI Tomato 2; and V_2: BARI Tomato 15

Single fruit weight and Fruit yield: Highest single fruit weight was found from P_0 (70.2g) (Table 1), whereas regards to combining effect, the highest single fruit weight was found from P_0V_1 (77.3 gm) (Table 2). The higher number of fruits and mean single fruit weight was found from pruned plants. There was not any significant effect on fruit yield through pruning (Table 1). However, tomato varieties in combination with different types of pruning showed significant effect in fruit yield (Table 2). The highest fruit yield was found from P_0V_1 (2.6 kg/plant and 86.1 t/ha) which was statistically similar with by P_3V_1 (2.5 kg/plant and 84.1 t/ha) (Table 2).

Seed production characteristics

Number of seeds per plant and their yield: Pruning effect did not show any significant variation for number of seed per fruit (Table 3). In case of combining effect, the highest number of seed was frond from P_0V_1 (181.7/fruit) and the lowest from P0V2 (105.0/fruit) (Table 4). Seed yield per plant was varied significantly by pruning. The highest seed yield was found from P_2 (14.5 g/plant) followed by P_1 (14.1 g/plant), while the lowest from P_3 (12.9 g/plant) (Table 3). The higher seed yield was also found from P_0V_1 combination (17.8 g/plant) (Table 4).

Treatments	Seed					
	Number/fruit	Yield (g/plant)	Viability	1000-seed wt. (g)	Filled (%)	Yield (kg/ha)
P_0	143.4^{a}	13.9^{ab}	70.5^{b}	3.0^{c}	91.0^{a}	56.8^{ab}
P_1	134.2^{a}	14.1^{ab}	51.2^{b}	3.2^{b}	81.9^{b}	48.2^{ab}
P_2	136.4^{a}	14.5^{a}	85.2^{a}	3.4^{a}	92.2^{a}	49.6^{a}
P_3	130.5^{a}	12.9^{b}	56.8^{c}	3.3^{b}	93.9^{a}	44.2^{b}
LSD(0.05)	19.6	1.5	3.5	0.1	5.3	4.4
CV (%)	8.2	6.1	3.1	1.9	10.8	5.3

Table 3: *Effect of pruning on the seed production of tomato.*

Note: *Values are means of three replicates; Values in a column with having similar and dissimilar superscript letter(s) are statistically similar (p>0.05) and different (p<0.05) respectively; P_0: Control, P_1: one shoot, P_2: two shoot, P_3: three shoot*

Treatments	Seed					
	Number/fruit	Yield (g/plant)	Viability	1000-seed wt (g)	Filled (%)	Yield (kg/ha)
P_0V_1	181.7^{a}	17.8^{a}	93.3^{b}	3.1^{c}	89.2^{ab}	60.2^{ab}
P_1V_1	152.9^{bc}	16.2^{b}	99.0^{a}	3.2^{c}	88.4^{ab}	55.1^{b}
P_2V_1	164.7^{ab}	16.8^{ab}	95.0^{b}	3.3^{b}	93.9^{a}	60.2^{a}
P_3V_1	150.6^{b}	13.8^{c}	99.0^{a}	3.1^{c}	93.4^{a}	47.3^{c}
P_0V_2	105.0^{c}	10.0^{e}	47.7^{d}	2.9^{d}	92.8^{a}	34.7^{e}
P_1V_2	115.5^{c}	12.0^{d}	3.3^{f}	3.2^{c}	75.4^{b}	41.4^{d}
P_2V_2	108.2^{c}	12.2^{d}	75.3^{c}	3.5^{a}	90.5^{ab}	42.5^{d}
P_3V_2	110.4^{c}	12.1^{d}	14.7^{e}	3.4^{ab}	94.4^{a}	41.1^{d}
LSD(0.05)	19.6	1.5	3.5	0.1	5.3	4.4
CV (%)	8.2	6.1	3.1	1.9	10.8	5.3

Table 4: *Effect of pruning-variety combinations on the seed production of tomato.*

Note: *Values are means of three replicates; Values in a column with having similar and dissimilar superscript letter(s) are statistically similar ($p > 0.05$) and different ($p < 0.05$) respectively; P_0: Control, P_1: one shoot, P_2: two shoot, P_3: three shoot; V_1: BARI Tomato 2; and V_2: BARI Tomato 15*

Seed viability: Seed viability was varied significantly among the different pruning. The highest seed viability was observed from P_2 (85.2%), while the lowest from P_3 (56.8%) (Table 3). Nevertheless, the P_1V_1 combination (99.0%) showed highest viability, which was statistically identical with P_3V_1 (99.0%) (Table 4).

1000 seed weight: 1000 seed weight showed significant variation by the application of different pruning to the tomato varieties (Table 3 and Table 4). The highest 1000 seed weight was from P_2 (3.4g), which was closely followed by P_1 (3.2g) (Table 3). The maximum 1000 seed weight was also found from P_2V_2 combination (3.5g) that was statistically similar with P_3V_2 (3.4 g) (Table 4).

Percentage of filled seed: Percentage of filled seed also showed significant variation among the pruning treatments and their combination with variety. The highest percentage of filled seed was obtained from P_3 (93.9%). P_2 (92.2%) and P_0 (91.0%) was statistically similar with P_3 (Table 3). The highest percentage of filled seed was found from P_3V_2 treatment combination (94.4%), which was closely followed by P_3V_1 (93.9%) and P3V1 (93.4%). All of the treatment combinations were statistically identical with P_3V_2 treatment (Table 4).

Seed yield: Seed yield showed significant variation by different pruning. The highest amount of seed was produced in P_2 (49.6 kg/ha), which was statistically similar with P_1 (48.2 kg) and P_0 (47.5 kg/ha) (Table 3). P_2V_1 (60.2 kg/ha) was found as the best treatment combination for seed yield that was statistically identical with P_0V_1 (56.8 kg/ha) (Table 4).

Discussion

Current study didn't show noticeable effect by side shoot pruning. But side shoot pruning can cause the early flowering by diversion of photosynthates that would have been used for growth of new shoots and leaves to flower production [32]. Fruit set was reduced in tomato plant at no side shoot pruning condition [33], which caused by the distribution of proper sunlight. Sunlight not only influences the flowering and fruit set but also enhances fruit quality and colour development of fruit [34]. The higher mean fruit weight could be attributed by the less number of photosynthates demanding shoots in pruned plants, which resulted in partitioning of more dry matter to the fruits. Bangladeshi farmers use excessive fertilizers that promote side shoot formation at early growing stage in tomatoes. Pruning of stem can increase fruit load by bringing back the balance source: sink ratio in plants [35]. Stem pruning increase in generative sink strength compared to the relative increase in source, and this not only increases overall fruit production but also reduces available assimilates per fruit [36]. Assimilate production is an influential factor for optimal fruit load [37]. Producers can maintain optimal fruit load by seasonal

assimilate supply through fruit pruning and changing stem density [38]. Pruning reduces disease pressure and leaf shading of fruit to protect them from sunburn which is also considered as an important factor [37]. Stem density can be altered through increased planting density or allowing side shoots to develop on plants. It is well documented that increasing plant density decreases total fruit yield per plant but increases yield per unit area [39,40]. Yield of tomato increased by shoot pruning due to the increased average fruit weight and number of fruit per plant. Our results are also agreed with Ara., *et al*. [9] and Huat., *et al* [41]. Pruning facilitates more stem; increased number of clusters; high fruit set percentage which leads to higher yield per plant. Atefeh., *et al*. [42] and Zhang [43] reported previously similar to our study. Seed production in BARI Tomato 2 was better than that of BARI Tomato 15. Pruning of the side shoot reduces the number of seed per fruit and seed yield; conversely it was better for seed viability, 1000-seed weight and percentage of filled seed. Germination and seedlings emergence requires a lot of energy which are supplied from the oxidation of seed storage materials. The average weight of 1000 seeds is important for seed quality [44,45].

Conclusions

Different stem pruning can influence the individual fruit weight, fruit yield, number of seed, seed viability, 1000 seed weight and seed yield. There was major difference in variety. BARI Tomato 2 showed higher seed production and viability than that of BARI Tomato 15. Shoot pruning is probably being considered as a technique to manipulate fruit load. But, pruning to multiple stems will probably require more stringent management of fruit load, at least for larger number of fruited cultivars, otherwise plants may become overly generative and long term productivity limited.

Conflict of Interest

No conflict of interest.

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