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EFFECTS OF IRRIGATION AND FERTILIZATION ON YIELD AND QUALITY OF LITCHI (*Litchi chinensis* Sonn.)

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ABSTRACT

An experiment was conducted in the litchi garden at Dinajpur district in Bangladesh from 15 October 2004 to 30 May 2005 to study the effect of irrigation and fertilization on yield and quality of litchi. The experiment was laid out in a randomized block design with three replications. The experiment consisted of three irrigation treatments viz. no irrigation, one irrigation and two irrigations, and four levels of NPK fertilizer (kg plant^{-1}) viz. 0-0-0, 0.75-0.88-0.62, 1.0-1.1-0.83 and 1.5-1.32-1.25. Two irrigations gave the highest yield and quality of litchi. The highest yield and best quality of litchi was obtained with highest levels of fertilizers. The combined effect of two irrigations and highest level of fertilizer (1.5 kg N, 1.32 kg P and 1.25 kg K) showed the best performance on the yield and quality of litchi.

Key words: *Irrigation, fertilizer, yield and quality of litchi*

INTRODUCTION

Poor farmers of Bangladesh are very much reluctant about management of fruit trees. Farmers are not taking any care of fruit trees like fertilization, irrigation, training, pruning, pest control etc. They plant the trees and after few years they harvest the product without giving any attention to its management practices. Among the management practices, irrigation and fertilization are two important factors for higher yield. Bangladesh produces only 14 thousand tones of litchi per annum from 14.86 thousand hectares of land (BBS, 2005) and the average per hectare yield of litchi is about 2.5 MT, which is also very low in comparison to those of other countries (Siddiqui, 1997). But the demand for fresh litchi is always very high due to its unique taste, flavour and colour though the supply of litchi is insufficient. Nitrogen is the major nutrient required for the growth of litchi plant. The deficiency of nitrogen results in stunted tree growth and small and pale green leaves. Nitrogen also has a profound influence on fruit set, fruit retention, length, diameter and weight of fruit. Litchi also requires a substantial quantity of potassium and phosphorus for its proper growth and yield. A proper coordination of fertilizer application vis-a–vis water management is essential to optimize its use and sustain yield. However, there are only a few published records on the effect of management practices on yield and quality of litchi. The present study, was therefore, initiated to evaluate the effects of irrigation and fertilization on yield and quality of litchi.

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MATERIALS AND METHODS

The experiment was conducted in the litchi garden of Dinajpur District in Bangladesh during the period from 15 October 2004 to 30 May 2005. The experimental area is located between $25^{o}13^{/}$ and $25^{o}4^{/}$ N latitudes and $88^{o}23^{/}$and $89^{o}18^{/}$ E longitudes at the mean elevation of 37 m above the sea level. It belongs to the AEZ, Old Himalayan piedmont plain. The soil texture is silty loam with pH 6.0-6.5. The mean temperature during the growing season varies from 10.7^{o}C to 22.8 ^{o}C and the level of humidity was around 81%. The two factor experiment was laid out in the randomized block design with three replications. Three levels of irrigation [I_0 = No irrigation, I_1 = One irrigation (20 litre plant^{-1}) and I_2 = Two irrigations (40 litre plant^{-1})] and four levels of fertilizer [F_0 = No NPK plant^{-1} (control), F_1 = Low level of NPK plant^{-1} (0.75 kg N, 0.88 kg P, 0.62 K), F_2 = Medium level of NPK plant^{-1} (1 kg, N 1.10kg P, 0.83 kg K) and F_3 = High level of NPK plant^{-1} (1.5 kg N, 1.32 kg P, 1.25 kg K)] were assigned at random to the litchi plants in the garden. So, total 3×4×3 = 36 litchi plants (ten year old plants, variety-Bedana) in three rows were selected in the orchard for the experiment. Each row was used as a block. In addition, cowdung and mustard oil cake was applied at the rate of 5 kg and 2 k g plant^{-1}. Manures and 50% of the inorganic fertilizers were applied in October 2004 by digging rings around the trees. Rest 50% of the inorganic fertilizer was applied again during March 2005 in the same ring around the trees before fruit setting. Two irrigations (I_2) were given, one after first application of fertilizer and another after second application of fertilizer. In case of one irrigation, it was applied after first application of fertilizer. . The base of the trees were kept weed free during the period of experimentation. Preventive measures were taken by applying cypermethrin (Ripcord/Cymbush/Arrivo) 10EC at the rate of 1.0 ml/litre before and after fruit setting to control the insect pest like litchi mite, caterpillar, litchi fruit borer etc.. Precautionary measures against disease infestation especially mosaic virus and fruit root were taken by spraying Dithene M-45 @ 4.5g/litree at the time of flowering. Fruits were harvested when they attained full maturity indicating fruit colour changes from greenish to pinkish red. Harvesting was done from 15 May to 24 May 2005. Ten panicles from each plant were selected at random and observations were made on fruit set, fruit drop, fruit length, fruit diameter and fruit weight. Fruit quality was determined by panel test method. Fruits plant^{-1} and fruit yield were obtained by counting and weighing all the litchi harvested from each plant, respectively. The data were analyzed statistically by means of computer package MSTAT. The differences among the treatment means were adjudged by the Duncan's Multiple Range Test (DMRT) as outlined by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Effect of irrigation

Irrigation exerted a significant influence on the yield characters, yield and quality of litchi (Table1). The number of fruits set panicle^{-1} recorded at two irrigation (I_2) was significantly higher than those produced in one irrigation (I_1) and control (I_0). The lowest number (12.63) of fruits set panicle^{-1} was obtained from I_0. The second highest number of fruits set was noticed at I_1 treatment. The highest fruits set at I_2 might be due to more availability and uptake of water at the time of setting of fruits in the trees. The highest number of fruit drop (2.22) was found in no irrigation (I_0) and was significantly higher than those of one irrigation (I_1) and two irrigations (I_2). However, no significant variation was observed in the number of fruit drop panicle^{-1} between the treatments I_1 and I_2. Irrigation water might have helped in fruit setting of plants,

and in nutrient uptake which ultimately reduced fruit drops. The maximum fruit length of 4.57 cm was obtained from the application of two irrigations which was identical with that of one irrigation. However, the fruit lengths in both the one and two irrigations were significantly higher than that of no irrigation treatment. Minimum length of fruit was recorded from no irrigation treatment (I_0). The diameter of fruits varied significantly due to the variation in irrigation management practices used in this experiment. Irrigation caused significant increase in diameter of fruits. The lowest diameter was recorded at the control treatment while the highest diameter was measured in two irrigations which was significantly higher than that obtained from one irrigation. The maximum weight of fruit (28.73 g) was observed in I_2 and it was statistically followed by those of I_1 and I_0. The highest weight of fruit in I_2 might be due to the important role played by irrigation in increasing plumpness of fruit. Among the three irrigation treatments, I_2 produced the highest number of fruits plant^{-1} (1274) and it was statistically followed by I_1 and I_0. The maximum number of fruit plant^{-1} was significantly higher than those of one (I_1) and no irrigation (I_0) treatments. The obtained result is in agreement with the finding of Singh *et al.* (2002) and Hasan and Chattopadhyay (1990). The fruit quality increased progressively with every increase in the level of irrigation showing significant difference in each case. The highest quality fruit was produced in I_2 and it was significantly higher than those of I_1 and I_2. The taste ranking panel casted the highest votes in favour of the fruits produce by two irrigations. This indicated that two irrigations in litchi orchard are necessary for quality and tasty fruit production.

Effect of fertilizer

Fertilizer exerted a significant influence on the yield characters, yield and quality of litchi (Table 2). The maximum number of fruits set panicle^{-1} (17.34) was produced with highest level of fertilizer application (F_3) and it was identically followed by medium and low levels (F_2 and F_1), but significantly higher than that of control (F_0). The treatment F_0 produced the lowest number of fruits set panicle^{-1} (15.18), but it was identical with F_1. Again F_1 and F_2 showed identical number of fruits set panicle^{-1}. Fruit drops were found to be reduced with the increasing levels of NPK fertilizers. The maximum fruit drop (2.22) was observed in the plants, which received no chemical fertilizer (F_0) and it was identical with that of F_1. From Table 2, it was observed that number of fruit drops panicle^{-1} decreased with the application of higher levels of fertilizer. The lowest number of fruit drop was noticed with the highest level of fertilizer level (F_3) and it was statistically followed by those of all other treatments. The second lowest number of fruits drop was recorded in F_2 but it was identical with that of F_1. The length of fruit varied significantly due to different levels of fertilizer application. The highest length (4.37cm) was obtained with the highest levels of fertilizer and it was statistically followed by those of F_2, F_1 and F_0. It was interesting to note that the length of fruit decreased with the decreasing levels of fertilizer application. The fruit diameter increased with the increasing levels of NPK fertilizers. The highest level of fertilizer (F_3) produced the highest fruit diameter (9.92cm) followed by those of the treatments F_2, F_1 and F_0, where the differences in the fruit F_0 = No NPK plant^{-1} (control), F_1 = Low level of NPK plant^{-1} (0.75 kg N, 0.88 kg P, 0.62 K), F2 = Medium level of NPK plant^{-1} (1 kg, N, 1.10 kg P, 1 kg K) and F_3 = High level of NPK plant^{-1} (1.5 kg N, 1.32 kg P, 1.25 kg K) diameters were significant in each case. The fruit weight increased progressively with the increasing levels of fertilizers. The F_3 treatment produced the highest fruit weight (26.69 g). The highest fruit weight was followed in the order of treatments F_2, F_1 and F_0 having significant differences among the levels. The obtained results are in agreement with the findings of sharma and Mahajan (1997), Chen et al. (1998), Dai et al. (1999) and Ghos and Mitra (1990). In general, the yield of fruits plant-1 was the highest under F_3 treatment.

Table 1. Effect of irrigation on yield characters, yield and quality of litchi

Irrigation	No. of fruits set panicle^{-1}	No. of fruits drop panicle^{-1}	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (gm)	Fruits plant^{-1}	Fruit quality
I_0	12.63 c	2.22 a	3.71 c	8.52 c	20.92 c	850 c	1.83 c
I_1	15.63 b	2.00 a	4.15 b	9.35 b	25.06 b	1027 b	2.17 b
I_2	20.41 a	1.68 b	4.57 a	11.00 a	28.73 a	1274 a	2.50 a
CV%	5.67	0.90	0.11	0.21	0.72	24.64	0.29
Level of significance	0.01	0.01	0.01	0.01	0.01	0.01	0.01

In a column, the figures having similar letters do not differ significantly at 0.01 level.
I_0- No irrigation, I_1- One irrigation and I_2- Twice irrigation

Table 2. Effect of Fertilizer on yield characters, yield and quality of litchi

Fertilizer	No. of fruits set panicle^{-1}	No. of fruits drop panicle^{-1}	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (gm)	Fruits plant^{-1}	Fruit quality
F_0	15.18 c	2.22 a	3.90 d	9.29 c	22.60 d	867 d	1.33 d
F_1	15.97 bc	2.08 ab	4.08 c	9.56 b	24.60 c	1022 c	1.67 c
F_2	16.39 b	1.87 bc	4.22 b	9.73 ab	25.71 b	1110 b	2.44 b
F_3	17.34 a	1.71 c	4.37 a	9.92 a	26.69 a	1202 a	3.22 a
CV%	5.67	0.90	0.11	0.21	0.72	24.64	0.29
Level of significance	0.01	0.01	0.01	0.01	0.01	0.01	0.01

In a column, the figures having similar letters do not differ significantly at 0.01 level.

The highest number fruits plant-1 (1202) in litchi was recorded in treatment F_3 and was followed by those of the treatments F_2, F_1 and F_0 where the differences in the fruits yield plant-1 were significant. The highest number of yield plant-1 in F_3 treatment might be due to the cumulative effects of higher number of fruits set and less dropping of fruits panicle-1. Similar results were also reported by sharma et al., (1990), Kadman and Tomer (1987), Lal and Tewari (1996) and Mathura et al. (2002). The best fruit quality (3.22) was recorded in F_3

followed by F_2, F_1 and F_0 treatments while the lowest (1.33) was in F_0 treatments. This indicated that a litchi plant required higher levels of fertilizer to produce tasty fruits.

Combined effect of irrigation and fertilization

Combination of irrigation and fertilization exested a significant influence only on fruit weight and number of fruits plant^{-1} of litchi (Table 3). It was evident from Table 3 that in general, there was an increasing trend in number of fruits set panicle^{-1} due to the combined effect of the

highest levels of fertilizers irrespective of irrigation level. Numerically, the maximum fruit set (21.63) was obtained from the highest levels of fertilizer and irrigation. ($I_2 \times F_3$). The lowest fruit set (11.40) was obtained from $I_0 \times F_0$ treatment combination. The combination of irrigation and fertilizer did not exert any significant influence on fruits drop panicle-1 (Table 3). However, the maximum fruit drop (2.53) was observed from $I_0 \times F_0$ treatment combination. The high level of irrigation and fertilization reduced fruit drop in litchi. The combined effect of irrigation and fertilizer application on fruit length was insignificant (Table 3).

Table 3. Combined effect of irrigation and fertilizer on yield characters, yield and quality of litchi

Irrigation x Fertilizer	No. of fruits set panicle^{-1}	No. of fruits drop panicle^{-1}	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (gm)	Fruits plant^{-1}	Fruit quality
I_0 x F_0	11.40	2.53	3.50	8.33	19.17 g	767 i	1.00
I_0 x F_1	12.07	2.30	3.70	8.50	20.50 fg	842 h	1.33
I_0 x F_2	12.93	2.13	3.77	8.57	21.67 ef	867 h	2.33
I_0 x F_3	14.10	1.93	3.87	8.70	22.33 e	925 g	2.67
I_1 x F_0	14.90	2.17	3.80	9.07	23.83 d	852 h	1.33
I_1x F_1	15.63	2.07	4.07	9.33	24.90 cd	987 f	1.67
I_1 x F_2	15.67	1.97	4.30	9.43	25.30 cd	1092 e	2.33
I_1 x F_3	16.30	1.80	4.43	9.57	26.20 c	1177 d	3.33
I_2 x F_0	19.23	1.97	4.40	10.47	24.80 cd	982 f	1.67
I_2 x F_1	20.20	1.87	4.47	10.83	28.40 b	1237 c	2.00
I_2 x F_2	20.57	1.50	4.60	11.20	30.17 a	1372 b	2.67
I_2 x F_3	21.63	1.40	4.80	11.50	31.53 a	1505 a	3.67
CV%	5.67	0.90	0.11	0.21	0.72	24.64	0.29
Level of significance	NS	NS	NS	NS	0.01	0.01	NS

In a column, the figures having similar letters do not differ significantly at 0.01 level.
NS indicates not significant

However, fruit length increased due to the interaction effect of higher levels of both irrigation and fertilizer or higher level of irrigation and irrespective of fertilizer levels. Fruit diameter did not vary due to interaction of irrigation and fertilizers used in this experiment. The lowest diameter (8.33) was recorded in the control treatment while the highest diameter was measured in $I_2 \times F_3$. The maximum but identical weight (31.53) of fruit was obtained from $I_2 \times F_3$ and $I_2 \times F_2$ treatment. The lowest fruit weight (19.17g) was obtained from the control ($I_0 \times F_0$) treatment. The higher fruit weight was obtained from the plants receiving higher levels of irrigation and

fertilizer. It might be due to increased fruit length and fruit diameter at higher levels of irrigation and fertilizer (Fig. 1 and 2). A significant positive correlation existed between fruit length and fruit weight ($r = 0.8765^{**}$) and also between fruit diameter and fruit weight ($r = 0.8128^{**}$). The highest levels of irrigation and fertilizer produced the highest number of fruits plant^{-1} (Table 3). $I_2 \times F_3$ produced the highest number of fruits plant^{-1}. The second highest number of fruits plant^{-1} was produced by the combined effect of $I_2 \times F_2$. In general, the combined effect of higher levels of both irrigation and level of NPK fertilizers was more favourable on the fruit yield. The higher fruit yield from higher level of irrigation and fertilizer might be due to increased fruit set panicle^{-1} and decreased fruits drop panicle^{-1} (Figs. 3 and 4). Because a significant positive correlation existed between number of fruits set panicle^{-1} and fruits plant^{-1} ($r = 0.8832^{**}$) and a significant negative correlation existed between number of fruits drop panicle^{-1} and fruits plant^{-1} ($r = 0.9405^{**}$). Fruit quality was not significantly influenced due to the combined effect of levels of irrigation and fertilization. However, combined effect of the highest levels of both irrigation and NPK fertilizers treatment ($I_2 \times F_3$) produced the best quality of litchi. Poor quality of fruit was produced by the combination of $I_0 \times F_0$.

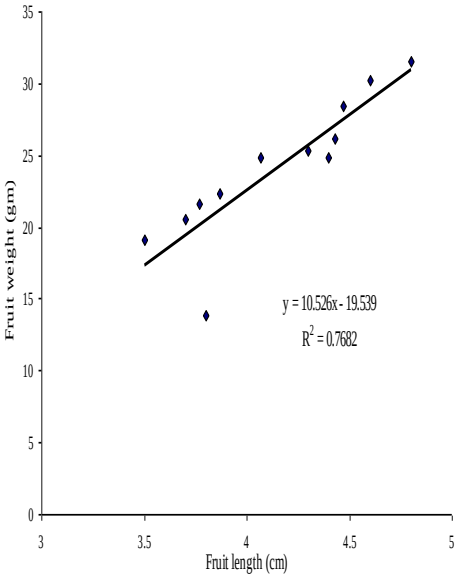

Fig. 1. Relationship between fruit length and fruit weight

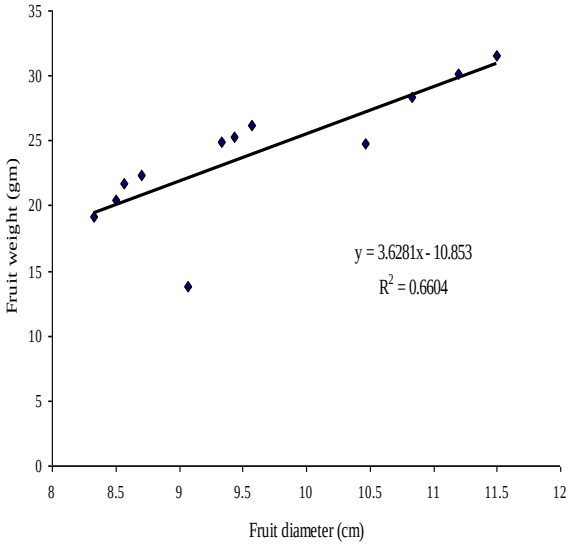

Fig. 2. Relationship between fruit diameter and fruit weight

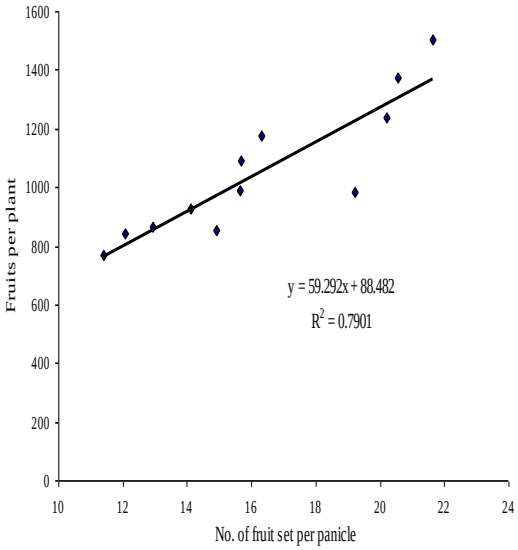

Fig. 3.Relationship between no. of fruit set per panicale and fruits per plant

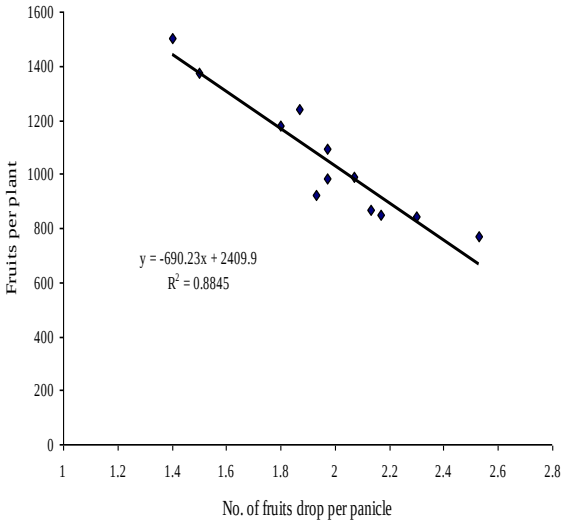

Fig. 4. Relationship between no. of fruits drop per panicle and fruits per plant

CONCLUSION

From the present study, it was observed that management practices especially irrigation and fertilizer management were very important for higher and quality fruit production of litchi. Results of the present study revealed that two irrigations along with higher levels of fertilizer application produced higher yield and quality litchi. Therefore, it may be suggested to apply irrigation two times in litchi garden in the month of October and March, respectively and fertilized with high levels of fertilizers i.e. 1.5 kg N, 1.32 kg P, 1.25 kg K plant^{-1}. In addition the plants should be manured with 2 kg of mustard oil cake and 5 kg of cowdung in the rings around the plants before first irrigation during the month of October.

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