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Influence of irrigation and different sources of nutrient on the fruiting behavior and yield of mango (*Mangifera indica* L)

Md. Shamsul. Alam[1*], Md. Rafiqul. Islam[2], Kazi Tahmina Akter[3], Md. Abdur Rouf[4] and Md. Rakibul. Islam[5],

Horticulture Division, Bangladesh Institute of nuclear Agriculture (BINA), Mymensingh
[1]Senior Scientific Officer, Horticulture Division, BINA, Mymensingh; [2]Principal Scientific Officer and Head, Horticulture Division, BINA, Mymensingh; [3&4]Scientific Officer, Horticulture Division, BINA, Mymensingh; [5]Program officer, Muktagacha South Ap,World Vision Bangladesh
**Corresponding author's E-mail: mithuhort@yahoo.com*

Abstracts
An experiment was conducted at the Horticulture Division of Bangladesh Institute of Nuclear Agriculture (BINA). Mymensingh during the period from February to July 2020 to study the effect of different sources of nutrients and irrigation on the fruiting behavior and yield of mango (CV.Amrapali). The study consisted of two factors: a) different sources of nutrients viz. i) no fertilization during the experimental period (control), ii) NPK fertilizations, iii)Poultry manures, iv) Cowdung and v) Compost; b) irrigation treatment viz, i) no irrigation during the experimental period ,ii) irrigation at 7 days interval after irrigation ,iii) irrigation at 14 days interval after irrigation. The experiment was laid out in Split Plot Design (SPD) with three replications. Almost all the parameters studied were found to be influenced by different sources of nutrients and irrigation. No. of inflorescence, number of fruits set (at pea stage),total number of fresh fruits, number of fruit drops, number of fruits cracks, fruit length ,fruit diameter, individual fruit weight, percent total number of fruit, percent fruit cracking, percent fruit dropping, total soluble solids(TSS) and yield per plant all were found superior in NPK applied plant. All the stated above parameters were also obtained superior from irrigation at 7 days interval than that of irrigation at 14 and 21 days interval. The combined effect of different sources of nutrients and irrigation revealed significant variation in fruiting behavior and yield. Treatment combination of NPK fertilizer and irrigation at 7 days interval produced the highest yield. The lowest fruiting behavior and yield was found in control treatments in case of main and combined effect.NPK fertilizer and 7 days interval irrigation application during flowering period is suggested to obtain higher yield in mango.

Key words: *Sources of nutrient, irrigation, fruiting behavior and yield*

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I. Introduction

Mango (*Mangifera indica* L.) is one of the most popular and commercially important fruit in Bangladesh and is called as the 'King of fruit" due to its excellent flavor, attractive color, delicious taste and high nutritive value. . It belongs to the family Anacardiaceae .It has be cultivated in this sub-continent from four thousand years ago (Candole, 1984). The fruit is believed to have originated in the Eastern India, Asam, Burma or in the Malayan region (Mukherjee, 1997). Mango grows in almost all over Bangladesh but commercial and good quality mangoes grown in the North-Western districts of the country. Due to certain limitations of soil and climatic conditions, the mango grows better in some selective areas of Bangladesh. The leading mango growing districts are Chapai Nawabgonj , Rajshahi, Naogaon, Rangpur, Dinajpur, Satkhira and Chuadanga. Mango is seasonal cash crop of North-Western region of Bangladesh which dominates the economy of Rajshahi and Chapainawabgonj district. More than 500 varieties of sweet edible mangoes can be found in Rajshahi and Chapainawabgonj district. It is estimated that around 85% people of the mentioned districts are directly or indirectly dependent on mango cultivation and business. It is grown over wide geographical areas particularly in India, Pakistan, Brazil, Mexico, Philippine, Indonesia, Thailand, Burma and Srilanka. It has gained popularity in Egypt, South –East Africa, Hawaii and North –West Australia. India is the largest producer of mangoes with approximately 66% of the world mango production (Jacob et al., 2018). In Bangladesh, it occupies an area of 37,830 hectares of land with an annual production of 116,1685 metric ton (MT). The average yield of mango in Bangladesh is about 4.47 ton per hectare (BBS, 2019).which is considered

much lower compared to that of the neighboring country like India (8.95 t/ha) (Ghosh, 2019). Most of the cultivated varieties of mango in this country are grown from seedlings and are mainly concentrated in north-western district. On the contrary, mangoes of unknown varieties (Gooti mangoes) are grown in the south-eastern and other parts of Bangladesh(Bhuyan,2019). The production of mango is greatly influenced by different fertilizer and irrigation along with other management practices. Fertilization is one of the most important intercultural operations that affect directly to the yield of mango. For getting optimum yield, the plants are required optimum nutrition after blossoming. If fertilizations not done at right time then yield is reduced as because fertilization few days before blossoming or during blossoming may lead to new vegetative growth reducing the flowering of mango and consequently the yield of mango. The number of fruits and quality of fruits enhance due to the fertilizer application after flowering. On the other hand, mango does not need irrigation water throughout the year but when it does, fairly heavy irrigation must be provided (Singh, 1968).The time of irrigation is, therefore, very important for maximization of yield. In case of bearing trees of mango, it is necessary to have a dry condition for three months after rainy season or up to flowering to get satisfactory bearing (Hossain,1994). It is believed that irrigation from the time of fruit set till the monsoon tends to prevent fruit drop and helps to improve is size and quality of the fruit (Singh, 1968). Proper fertilizers and flood irrigation helps in retention of maximum fruits at bearing stage. Application of water recommended soon after emergence of inflorescence, at fruit set and thereafter at 15 days interval (Hossain *et al.*, 2019). Keeping the above stated facts in mind the present piece of study was undertaken with the following objectives: i) to increase the flowering and fruiting in mango by applying different fertilization and irrigation, and ii) to increase the yield of quality mango per unit area.

II. Materials and Methods

An experiment was conducted at the Horticulture Division of Bangladesh Institute of Nuclear Agriculture (BINA).Mymensingh during the period from February to July 2020 to study the effect of different sources of nutrients and irrigation on the fruiting behavior and yield of mango (CV. Amrapali). The study consisted of two factors: a) different sources of nutrients viz. i) no fertilization during the experimental period (control) ii) NPK fertilizations, iii) Poultry manures iv) Cowdung and v) Compost; b) irrigation treatment viz, i) no irrigation during the experimental period ,ii) irrigation at 7 days interval after irrigation ,iii) irrigation at 14 days interval after irrigation. The experiment was laid out in Split Plot Design (SPD) with three replications. The plants were previously planted and the age of plant was seven years. The whole experimental area was divided into 3 blocks . Each block was again divided into 5 main plots and each main plot was again subdivided into 4 subplots .There were all together 60 unit plots .The irrigation treatments assigned to the main plots order of level of irrigation and treatments were assigned randomly to the subplots. Total manure and fertilizers application was done just after flowering at February 14, 2020 and irrigation was done just after manure and fertilizer application .The following doses of manures and fertilizers(well decomposed cowdung-25kg, compost-30kg, poultry manuare-20kg, urea-500gTSP-110g and MoP-166g) were applied to each mango plant following the recommendation of FTIP, 2004.All manures and fertilizers were mixed together and applied around to plant base and irrigation application was done using rising ring method. Irrigation applications were give as per treatment schedule at 7, 14 and 21 days interval up to mature stages of fruits .The total irrigation water that was applied 9,504 liter .The control plants of each replication were not irrigation throughout the experimental period. The experimental area was kept under careful observation .Weeding and mulching were done regularly whenever necessary to keep the orchard free from weed and to pulverize the soil. To control insects and diseases, insecticides and fungicides were applied at regular interval.

III. Result and Discuss

Main effect of different sources of nutrient on the fruiting behavior and yield of mango

Different sources of nutrients showed significant influence on all the parameters. The maximum number of fruits set (at pea stage) per plant (219.67), length of fruits (8.59cm) ,diameter of fruits (5.86cm) , total number of fresh fruits per plant (133) , Individual fruit weight (279.59g), percentage of total number of fresh fruits per plant (59.69%) and total soluble solid (TSS) (22.73) were obtained from NPK treatments except number of inflorescences per plant ,dropped and cracked fruit per plant as well as percentage of dropped and cracked fruit per plant. The highest number of inflorescences per plant (167.28), dropped (74.28) and cracked (25.50) fruit per plant as well as percentage of dropped (31.00%) and cracked (21.37%).fruit per plant were found in control plant, while the lowest values of all the above mentioned parameters were found in control treated plants except number of inflorescence per plant. . This happened probably due to the fact that C: N ratio was disturbed in NPK applied plants. On the other hand, poultry manure fertilized plant the maximum gained the C: N ration by the plant, which helped in producing the highest number of inflorescences per plant. In case of no fertilized plant C: N ratio remained undisturbed. The lowest number of inflorescences per plant (149.95) was found in compost treated plant. The lowest dropped (53.76) and cracked (11.92) fruit per plant as well as

percentage of dropped (29.69%) and cracked (6.47%) fruit per plant values were found in NPK treated plants. When yield was considered, NPK treated plants produced the highest yield (37.45 Kg/Plant) while the lowest (6.58 Kg/Plant) was obtained from control plants. Similar results are in agreement with Banik *et al.*, (1997),Banik and Sen (2001) , ABD EL-RAHMAN(2011)., and Sing (2000).They reported that macronutrients like nitrogen, phosphorus and potassium are important nutrients for plant growth, fruit retention and development and yield during flowering period. Alvilan and Figueroa (1977) reported that the highest yield was obtained by applying nitrogen, P2O5 and K2O at 80:30:30 Kg per hectare applied to mature kent, smith and zill varieties at flowering stage.

Table 1. Main effect of different sources of nutrients on the fruiting behavior and yield of mango.

Treatment Different sources of nutrients	Number of Inflorescence per plant	Number of fruits set (at pea stage) per plant	Number of fruits dropped per plant	Number of fruits cracked per plant	Fruit length (cm)	Fruit diameter (cm)
M_0	167.28	129.00	74.28	25.50	5.59	3.75
M_1	166.90	219.67	53.76	11.92	8.59	5.86
M_2	165.25	158.33	56.59	16.25	7.19	4.76
M_3	153.47	171.92	65.69	11.99	7.57	5.37
M_4	149.95	143.33	54.78	15.25	6.67	5.07
LSD(0.05)	4.49	4.19	3.39	0.4/	0.35	0.27
LSD(0.01)	12.47	6.47	5.27	0.79	0.58	0.49

Table 1. cont'd

Treatment Different sources of nutrients	Total number of fresh fruit per plant	Individual fruit weight (g)	Total soluble solids (%)	% Total number of fruits per plant	% Fruits cracked per plant	% Fruits dropped per plant	Yield (Kg/plant)
M_0	29	205.89	21.34	31.00	21.37	47.47	6.58
M_1	133	279.59	22.73	29.69	6.47	32.65	37.45
M_2	82	242.27	21.76	55.88	11.54	36.09	19.84
M_3	95	251.98	22.23	55.70	8.85	35.52	23.84
M_4	73	234.97	21.72	49.38	12.93	37.19	17.08
LSD(0.05)	4.23	8.89	0.04	1.15	0.58	1.85	
LSD(0.01)	6.14	11.96	0.06	1.67	0.89	2.84	

M_0= No fertilizer during the experimental period (control)
M_1= NPK
M_2= Poultry manure
M_3= well decomposed cowdung
M_4= Compost

Main effect of irrigation on the fruiting behavior and yield of mango

Irrigation at different day's interval had significant influence on all the parameters. The maximum number of inflorescence per plant , number of fruit set (at per stage) per plant ,individual fruit weight ,number of fruit dropped per plant ,number of fruits cracked per plant ,length of fruits ,diameter of fruits ,total number of fresh fruits per plant ,percentage of total number of fresh fruits per plant and total soluble solids (TSS) were found in on irrigated at 7days interval except number of inflorescence per plant while the lowest values of all the above mentioned parameters were found in on irrigated plants .The production of the highest individual fruit weight was possibly due to application of irrigation just after fertilization which helped solubilizing the fertilizers and reaching to the root zone rapidly. The highest percentage of fruit dropped and fruit cracked per plant were found in control plants while the lowest values were found in 7 days interval irrigated plants .When yield was considered, irrigated at 7days interval treated plants produced the highest (30.56Kg) yield while the lowest (10.35Kg) was obtained from control plant .The highest yield in stated treatment was produced ensured maximum use of fertilizer by reaching to the root zone of plant. This finding agrees with Chadha (2001), Liu *et al*., (2007), and Liu,*et al.*, (2011). Wager *et al.*,(1984) reported that trees irrigated to field capacity at 7 days intervals from March to May produced higher yields (287.53kg/plant) than trees irrigated at 14 or 21 day intervals (177.45 and 96.25 kg/plant, respectively). Hayes (1957) also reported that irrigation after fertilization produced larger fruit. Water resource scarcity worldwide makes it necessary to understand the effects of water use reduction in more efficient and competitive crop irrigation. Even though mango is a drought-resistant crop, fruit tree production plays an important role and the efficient use of water resources is mandatory. Cell enlargement and division need adequate water during fruit growth and development period, while lack of water inhibited fruit growth and development. Most of the mango fruit development of natural mango fruits takes

place during the dry season and farmers have to irrigate mango trees to ensure high yields and good quality of mango (Liu *et al.,(*2014) and Zhou *et al.,(*2020) .

Table 2 . Main effect of irrigation on the fruiting behaviour and yield of mango.

Treatment Different sources of nutrients	Number of Inflorescence per plant	Number of fruits set (at pea stage) per plant	Number of fruits dropped per plant	Number of fruits cracked per plant	Fruit length (cm)	Fruit diameter (cm)
I_0	146.80	125.47	52.80	18.8	6.54	4.35
I_1	168.80	198.27	64.87	13.6	7.44	5.36
I_2	147.80	172.07	61.80	15.23	7.20	5.17
I_3	137.33	147.60	55.27	16.8	6.92	4.84
LSD(0.05)	3.67	3.48	3.23	1.06	0.16	0.17
LSD(0.01)	5.31	5.00	4.67	1.53	0.23	0.24

Table 2. cont'd

Treatment Different sources of nutrients	Total number of fresh fruit per plant	Individual fruit weight (g)	Total soluble solids (%)	% Total number of fruits per plant	% Fruits cracked per plant	% Fruits dropped per plant	Yield (Kg/plant)
I_0	50.32	205.79	24.52	39.87	16.27	43.46	10.35
I_1	118.45	259.45	24.6	58.40	7.8	33.53	30.56
I_2	93.23	256.8	24.67	53.20	9.93	36.73	23.81
I_3	72.12	255.24	24.41	49.00	12.42	38.13	18.36
LSD(0.05)	3.54	10.00	3.01	1.23	0.62	2.13	2.12
LSD(0.01)	5.21	14.48	4.56	1.78	0.89	2.82	3.26

I_0= No Irrigation applied during the experimental period (control)
I_1= Irrigation at 7 days interval
I_2= Irrigation at 14 days interval
I_3= Irrigation at 21days interval

Combined effect of different sources of nutrient and irrigation on the fruiting behavior and yield of mango

Combined effect of different sources of nutrients and irrigation exhibited mark influence on all the parameters studied .The maximum values of all the characters were obtained from the treatment combination of NPK treated with 7 days interval irrigated plant.The maximum yield (52.23Kg) per plant was obtained from the treatment combination of NPK fertilization and irrigation at 7 days interval after fertilization and minimum yield (3.46Kg) per plant was recorded when the plants were not fertilized and irrigation after fertilization. The highest yield was in the said combination was due to availability of nutrition at right time i.e. during fruit growth and development and the lowest yield was produced due to lack of proper nutrients availability and soil moisture . There are many factors such as high ratio of male flowers, pollination failure among the perfect the flowers, germination failure, poor pollen tube growth and unfavorable weather condition prevailing at anthesis which are responsible for low fruit retention.

Table 3. Combined effect of different sources of nutrients and irrigation on the fruiting behaviour and yield of mango

Treatment Different sources of nutrients	Number of Inflorescence per plant	Number of fruits set (at pea stage) per plant	Number of fruits dropped per plant	Number of fruits cracked per plant	Fruit length (cm)	Fruit diameter (cm)
M_0I_0	155.00	93.33	48.33	25	4.98	3.41
M_0I_1	172.00	138.33	60.00	22	5.31	3.67
M_0I_2	140.33	115.00	52.00	23	5.93	3.85
M_0I_3	141.00	105.33	48.00	24	5.47	3.97
M_1 I_0	116.00	169.67	68.68	16	7.40	4.86
M_1 I_1	167.00	270.33	78.68	10	9.23	6.51
M_1 I_2	152.33	237.33	75.68	12.67	8.91	6.25
M_1 I_3	128.33	193.33	65.68	13	8.62	5.61
M_2 I_0	158.33	83.67	35.68	15	6.98	4.44
M_2 I_1	185.33	195.00	63.00	12	7.67	4.93
M_2 I_2	153.67	178.00	65.68	14	7.05	4.89
M_2 I_3	147.67	148.67	58.00	16	6.81	4.57
M_3 I_0	145.67	160.67	66.68	18	7.23	4.94
M_3 I_1	147.67	210.67	64.68	11	7.89	6.09
M_3 I_2	167.00	181.67	57.68	13	7.85	5.45

M_3 I_3	136.33	166.67	57.68	14	7.22	4.86
M_4 I_0	158.00	120.00	50.00	20	6.08	4.08
M_4 I_1	171.33	177.00	58.00	13	7.09	5.59
M_4 I_2	125.67	148.33	58.00	15	6.77	5.42
M_4 I_3	133.33	124.00	49.00	17	6.47	5.21
LSD(0.05)	2.84	2.68	1.81	0.82	0.12	0.13
LSD(0.01)	4.85	3.88	2.62	1.19	0.17	0.19

Table 3. cont'd

Treatment Different sources of nutrients	Total number of fresh fruit per plant	Individual fruit weight (g)	Total soluble solids (%)	% Total number of fruits per plant	% Fruits cracked per plant	% Fruits dropped per plant	Yield (Kg/plant)
M_0I_0	18.32	189.04	25.50	21.33	26.68	52.00	3.46
M_0I_1	55.65	198.72	25.03	40	16	43.33	10.89
M_0I_2	48.32	215.48	25.06	35	20	46.67	10.32
M_0I_3	38.54	232.03	25.57	31.67	22.78	45.68	12.61
M_1 I_0	88.54	223.17	23.10	50	9.33	40.33	19.62
M_1 I_1	180.58	307.2	24.20	67	4.68	29.00	52.23
M_1 I_2	148.35	292.78	24.10	62.67	5.00	31.68	43.23
M_1 I_3	112.23	282.93	23.53	59	6.68	33.68	31.58
M_2 I_0	22.35	208.30	25.07	39.67	17.68	42.00	4.57
M_2 I_1	114.45	262.97	24.73	61.33	6.00	32.00	29.86
M_2 I_2	98.37	258.31	24.60	55	7.68	36.68	25.28
M_2 I_3	78.58	251.48	24.63	51.33	10.68	37.68	19.57
M_3 I_0	75.32	218.30	24.10	47	11.00	41.33	16.35
M_3 I_1	119.89	276.34	24.17	64	5.00	30.68	32.84
M_3 I_2	115.45	265.35	24.43	63	7.00	31.68	30.47
M_3 I_3	95.74	259.81	24.20	57	8.33	34.33	24.61
M_4 I_0	32.89	190.13	24.93	41.33	16.68	41.68	22.04
M_4 I_1	99.38	253.78	24.87	59.67	7.33	32.68	25.14
M_4 I_2	69.78	252.05	24.93	50.33	10.00	39.00	17.38
M_4 I_3	56.47	249.95	24.13	46	13.68	39.33	13.94
LSD(0.05)	7.89	7.74	0.11	0.95	0.48	1.41	5.58
LSD(0.01)	11.65	11.20	0.16	1.38	0.69	2.40	7.47

IV. Summary

Different sources of nutrients showed significant influence on all the parameters. The maximum number of inflorescences per plant ,number of fruits set (at per stage) per plant , number of fruits dropped per plant ,number of fruits cracked per plant ,length of fruits ,diameter of fruits ,total number of fresh fruits per plant , percentage of total number of fresh fruits per plant and total soluble solid (TSS) were obtained from NPK treatments ,while the lowest values of all the above mentioned parameters were found in control treated plants except number of inflorescence per plant .The highest percentage of fruit dropped and fruit cracked per plant were found in control plants while the lowest values were found in NPK treated plants. When yield was considered, NPK treated plants produced the highest (37.45 Kg) yield while the lowest (6.45 Kg) was obtained from control plants .Irrigation at different day's interval had significant influence on all the parameters. The maximum number of inflorescence per plant , number of fruit set (at per stage) per plant ,number of fruit dropped per plant ,number of fruits cracked per plant ,length of fruits ,diameter of fruits ,total number of fresh fruits per plant ,percentage of total number of fresh fruits per plant and total soluble solids (TSS) were found in on irrigated at 7days interval except number of inflorescence per plant while the lowest values of all the above mentioned parameters were found in on irrigated plants .The highest percentage of fruit dropped and fruit cracked per plant were found in control plants while the lowest values were found in 7 days interval irrigated plants .When yield was considered ,NPK treated plants produced the highest (300.56Kg) yield while the lowest (10.35Kg) was obtained from control plant .Combined effect of different sources of nutrients and irrigation exhibited mark influence on all the parameters studied .The maximum values of all the characters were obtained from the treatment combination of NPK treated with 7 days interval irrigated plant .NPK fertilization with 7 days interval irrigated plants gave the highest (52.23Kg) yield and the minimum (3.46Kg) yield was found from on fertilized and irrigated plants.

V. Conclusion

NPK fertilization and 7 days interval irrigated plants produced the maximum yield showing the best performance in respect of all the yield and yield attributes. Both fertilization and irrigation was likely proper growth, development and retention of young fruit leading to better yield of mango before fruit setting period.

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Md. Shamsul. Alam, et. al. "Influence of irrigation and different sources of nutrient on the fruiting behavior and yield of mango (Mangifera indica L)." *IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS),* 15(04), 2022, pp. 19-24.