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Effect of planting time and fertilizer dose on growth, yield and quality of bitter gourd grown under polyhouse and net house conditions

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ABSTRACT

An experiment was conducted to study the effect of planting time and fertilizer dose on growth, yield and quality of bitter gourd var. Pusa Rasdar under two different protected structures (polyhouse and nethouse). The experiment was laid out in the factorial randomized block design with three replications. The treatments were formulated with four fertigation levels (15:7:16, 20:12:21, 25:17:26 and 30:22:31 kg NPKha^{-1}) and three date of plantings (15th August, 1st September and 15th September). Among the treatments combination, 15th August sowing with 30:22:31 kg NPKha^{-1} shown highest interaction effect for the number of fruits per plant (11.47), fruit weight (235.26 g), yield per plant (2697.7 g), yield per 1000m^2 (107.91 q) under nethouse. Whereas, 15th August planting with 30:22:31 kg NPKha^{-1} recorded highest for nitrogen (236.10 mg/100g), phosphorus (41.00 mg/100g), potassium (346.33 mg/100g), calcium (19.33 mg/100g), iron (0.32 mg/100g), zinc (0.64 mg/100g) and manganese (0.42 mg/100g) content of bitter gourd fruit grown under polyhouse. Hence, cultivation of bitter gourd var. Pusa Rasdar at 15th August planting with application of 30:22:31 kg NPKha^{-1} under the insect-proof nethouse found better for the successful plant growth, yield and quality.

Key words: *Momordica charantia*, protected structures, fertigation, mineral content.

INTRODUCTION

Bitter gourd (*Momordica charantia L.*), Cucurbitaceae, is a vegetable with tropical and subtropical distribution. Bitter gourd is ranking first among cucurbits for its nutrition value apart from being a good source of carbohydrates, proteins, vitamins and mineral (Behera *et al*., 3). It has a prime place in folk medicine, cuisines especially in India and south-east Asia, and also for ornamental value (Heiser, 8). Recent day bitter gourd production is gaining importance due to the spread of awareness among consumers regarding its medicinal properties leading to elevated demand and higher yield and income in short period of time which attracting more farmers towards bitter gourd cultivation. Being warm season crop, frost injury during the winter season is the limiting factor for successful cultivation, which adversely affects the overall morphological growth, fruit set and ultimately interrupts supply chain. Under such prevailing condition protected cultivation under polyhouse and insect proof net houses can be a viable option to provide the specified climate for crop growth. Hence, in order to extend the area of bitter gourd under protected cultivation in India, Indian Agricultural Research Institute (IARI) had developed and released bitter gourd variety Pusa Rasdar for protected cultivation (Anonymous, 2).

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In crops like cucurbits, mere providing of specified climate for the crop is not sufficient because other factors like planting time and nutrient composition especially nitrogen known to have the decisive role in the successful production with enhanced productivity *via* affecting sex expression (Seshadri, 13). Now it is well known fact that nitrogen at higher dose promotes the plant to produce more number of male flowers and *vice versa* in bitter gourd (Seshadri, 13). Hence, specifying the date of planting and amount of fertilizer to be applied to decrease sex ratio (male:female) and enhance the productivity of bitter gourd under protected conditions is important for its successful cultivation. However, very few reports are available on bitter gourd production under the protected condition in India. Hence present investigation was under taken to find out the suitable planting time and fertilizer dose for bitter gourd cultivation under protected conditions.

MATERIALS AND METHODS

The experiment was conducted at Centre for Protected Cultivation Technology (CPCT), Indian Agricultural Research Institute (IARI), New Delhi, India from August 2015 to January 2016. An experiment was laid out in a factorial randomized block design with three replications. The treatments were formulated with four different doses of NPK fertilizers applied at rate of 15:7:16 kgha^{-1} (D_1), 20:12:21 kgha^{-1} (D_2), 25:17:26 kgha^{-1} (D_3) and

30:22:31 kgha^{-1} (D_4); three date of plantings *viz*., 15th August (P_1), 1st September (P_2) and 15th September (P_3) under two different protected structures *viz.,* insect proof net house (S_1) and naturally ventilated polyhouse (S_2). Planting was done at a spacing of 50x30 cm and all the recommended cultural practices were carried throughout the growing season. To meet the requirement of recommended doses of plant nutrients, urea (46:0:0), urea phosphate (17:44:0) and potassium sulphate (0:0:50) were taken as a source of nitrogen, phosphorus and potassium respectively. Hand pollination was carried out by dusting the pollen from male flowers between 6.00-9.00 AM regularly after initiation of flowering. Fruits were oven dried at 70^{o}C and crushed into powder form to determine the fruit mineral content. For nitrogen content, samples were digested according to the method of Chapaman and Pratt (5) and total nitrogen content was determined using the Kjeldahl method. Phosphorus content was determined by using the method proposed by Jackson (9). According to the method of Knudsen *et al*. (10) potassium content was determined by Flame Photometer. For trace elements analysis, the method by Edward (6) was applied by using atomic absorption spectrophotometer (AAS). Data were analyzed using the SAS package (9.3 SAS Institute, Inc, USA). The F and P values ≤ 0.05 were calculated and considered as significant.

RESULTS AND DISCUSSION

As per the results, three factors significantly affected the response measurements either individually or combined effects (interactions). Protected structures, planting time and fertigation levels showed significant variation for most of the Pusa Rasdar bitter gourd characters studied (Table 9).

The effect of different treatments combination on flowering characters is presented in Table 1 and 2. The earliness for first male flower (22.67 DAS), female flower (25.33 DAS) and first male flower on early node (5.49) were noticed nethouse. Data on fertigation levels showed that lesser number of days required for the initiation of first male and female flower at the higher dose of fertilizers application. The results revealed that early male (22.53 DAS) and female flowers (24.82 DAS) were induced by 30:22:31 kg NPK ha^{-1} of fertilizer application under net house. The early appearance and increased production of male and female flowers by higher levels of fertilizers application might be attributed to the fast growth of vine which favoured flower forming hormone like Gibberellic acid (GA) those may have induced production of flowers. The date of planting also exhibited marked influence on flowering related characters of bitter gourd. Bitter gourd produced early male flower (21.65 DAS) and female flower (24.00 DAS) at 15th Aug planting under polyhouse. This might be associated with high temperature with optimum relative humidity at 15th Aug planting under polyhouse, which promoted the rapid activation of seed embryo, seed germination and rapid growth of seedlings (Binder *et al*., 4). Similarly, first male (5.03) and female flower (11.90) were produced on an early node at 15th Aug planting under net house and polyhouse respectively. The study revealed that there are no significant interactions for flowering characters of bitter gourd under both structures. Among the combinations, 15th Aug planting with 15:7:16 kg NPKha^{-1} showed early male flowering (22.47 DAS) on lower node 4.80 under net house. On other hand 15th Aug planting with 20:12:21 kg NPKha^{-1} produced early female flower (23.80 DAS) on the lower node (11.53) under polyhouse.

The influence of different treatments combination on yield and yield attributing characters are presented in Table 3, 4, and 5. Improvement in fruit set and development is considered to be pre-requisite to increase the yield of bitter gourd. Among the two protected structures highest numbers of fruits per plant (8.03), fruit weight (198.76 g), yield per plant (1655.5 g) and yield per 1000m^2 (66.22 q) were noticed in nethouse. Whereas, the highest fruit length (13.29cm), fruit diameter (5.78 cm) and flesh thickness (1.15 cm) were noticed under polyhouse. It is obvious that increased yield potential is achieved at the expense of the number of fruits per plants in nethouse rather than fruit weight in polyhouse. The yield of bitter gourd grown at different levels of fertigation differed significantly that the highest fruit length (14.40 cm), fruit diameter (6.04 cm) and flesh thickness (1.21 cm) was obtained with the application of 25:17:26 kg NPKha^{-1} under polyhouse. However, the highest number of fruits per plant (8.92), yield per plant (1981.4 g) and yield per 1000m^2 (79.26q) were reported by the application of 30:22:31 kg NPKha^{-1} under net house. The lowest yield (48.43 q/1000m^2) was reported at application of lower dose of fertilizer (15:7:16 kg NPKha^{-1}) under polyhouse. It was also reported that increased fertigation level increases photosynthetic activities, protein synthesis and translocation of photosynthate which promotes the production of more number of fruits per plant with increased fruit weight. The results obtained are in consonance to the reports of Ahmed *et al.* (1) in cucumber and Maluki *et al.* (11) in watermelon. The date of planting also exhibited marked influence on all the yield and yield components of bitter gourd. The highest number of fruits per plant (10.08), fruit weight (216.02 g),

Table 1. Effect of planting time and fertilizer dose on days to opening of first male and female flower of bitter gourd var. Pusa Rasdar under polyhouse and nethouse conditions.

Treatments	Days to opening of first male flower								Days to opening of first female flower							
	Date of Planting								Date of Planting							
	Nethouse (S1)				Polyhouse (S2)				Nethouse (S1)				Polyhouse (S2)			
(N:P:K)	P1	P2	P3	Mean	P1	P2	P3	Mean	P1	P2	P3	Mean	P1	P2	P3	Mean
D1	22.27	22.47	23.33	22.69	21.60	22.87	23.73	22.73	25.00	25.27	26.20	25.49	24.00	25.73	27.07	25.60
D2	22.53	22.40	23.13	22.69	22.13	22.80	23.07	22.67	24.93	25.53	26.13	25.53	23.80	25.87	26.87	25.51
D3	22.87	22.33	23.07	22.76	21.33	22.87	23.33	22.51	24.73	25.13	26.53	25.47	23.93	25.33	27.20	25.49
D4	22.73	22.33	22.53	22.53	21.53	24.07	23.60	23.07	23.33	25.20	25.93	24.82	24.27	25.93	27.07	25.76
Mean	22.60	22.38	23.02	22.67	21.65	23.15	23.43	22.74	24.50	25.28	26.20	25.33	24.00	25.72	27.05	25.59

D_1:15:7:16 kgha^{-1}, D_2: 20:12:21 kgha^{-1}, D_3: 25:17:26 kgha^{-1}, D_4: 30:22:31 kgha^{-1}; P_1:15th August, P_2: 1st September, P_3:15th September

Table 2. Effect of planting time and fertilizer dose on appearance first male and female flower early node of bitter gourd var. Pusa Rasdar under polyhouse and nethouse conditions.

Treatments	Node of first male flower								Node of first female flower							
	Date of Planting								Date of Planting							
	Nethouse (S1)				Polyhouse (S2)				Nethouse (S1)				Polyhouse (S2)			
(N:P:K)	P1	P2	P3	Mean	P1	P2	P3	Mean	P1	P2	P3	Mean	P1	P2	P3	Mean
D1	4.80	6.00	5.27	5.36	5.27	5.80	5.53	5.53	12.53	12.67	11.47	12.22	11.80	12.40	12.67	12.29
D2	4.93	5.93	5.67	5.51	5.07	5.80	5.47	5.44	12.93	12.87	11.93	12.58	11.53	12.00	12.80	12.11
D3	5.33	5.93	5.60	5.62	5.67	5.67	5.20	5.51	12.47	13.20	12.47	12.71	11.80	12.33	12.53	12.22
D4	5.07	5.87	5.53	5.49	5.60	5.60	5.53	5.58	12.53	13.07	12.40	12.67	12.47	12.33	12.60	12.47
Mean	5.03	5.93	5.52	5.49	6.15	5.72	5.43	5.77	12.62	12.95	12.07	12.54	11.90	12.27	12.65	12.27

D_1:15:7:16 kgha^{-1}, D_2: 20:12:21 kgha^{-1}, D_3: 25:17:26 kgha^{-1}, D_4: 30:22:31 kgha^{-1}; P_1:15th August, P_2: 1st September, P_3:15th September

Table 3. Effect of planting time and fertilizer dose on fruit length (cm) and diameter (cm) of bitter gourd var. Pusa Rasdar under polyhouse and nethouse conditions.

Treatments	Fruit length (cm)								Fruit diameter (cm)							
	Date of Planting								Date of Planting							
	Nethouse (S1)				Polyhouse (S2)				Nethouse (S1)				Polyhouse (S2)			
(N:P:K)	P1	P2	P3	Mean	P1	P2	P3	Mean	P1	P2	P3	Mean	P1	P2	P3	Mean
D1	11.59	12.95	12.64	12.39	11.38	12.41	11.89	11.89	6.08	4.98	5.90	5.65	6.31	4.95	5.32	5.53
D2	13.65	12.76	12.92	13.11	12.77	12.88	13.46	13.04	5.83	5.29	6.00	5.71	5.83	5.10	5.95	5.63
D3	15.07	14.11	13.07	14.09	14.16	13.97	15.08	14.40	6.03	5.48	6.07	5.86	5.91	6.09	6.13	6.04
D4	13.90	13.63	12.93	13.48	13.60	13.54	14.38	13.84	5.74	5.55	5.83	5.70	5.81	6.08	5.84	5.91
Mean	13.55	13.36	12.89	13.27	12.98	13.20	13.70	13.29	5.92	5.33	5.95	5.73	5.96	5.56	5.81	5.78

D_1:15:7:16 kgha^{-1}, D_2: 20:12:21 kgha^{-1}, D_3: 25:17:26 kgha^{-1}, D_4: 30:22:31 kgha^{-1}; P_1:15th August, P_2: 1st September, P_3:15th September

Table 4. Effect of planting time and fertilizer dose on number of fruits/plant and fruit weight (g) of bitter gourd var. Pusa Rasdar under polyhouse and nethouse conditions.

Treatments	Number of fruits								Fruit weight (g)							
	Date of Planting								Date of Planting							
	Nethouse (S1)				Polyhouse (S2)				Nethouse (S1)				Polyhouse (S2)			
(N:P:K)	P1	P2	P3	Mean	P1	P2	P3	Mean	P1	P2	P3	Mean	P1	P2	P3	Mean
D1	8.20	8.20	4.13	6.84	7.73	7.47	5.87	7.02	190.92	182.63	160.99	178.18	183.97	168.88	161.73	171.52
D2	9.27	8.53	4.53	7.44	8.47	7.87	6.67	7.67	203.61	194.99	167.93	188.84	202.05	188.31	182.85	191.07
D3	11.40	10.07	5.20	8.89	9.07	9.07	7.13	8.42	234.27	228.78	177.52	213.52	226.40	225.98	209.56	220.65
D4	11.47	10.03	5.27	8.92	9.00	8.93	7.20	8.38	235.26	230.03	178.23	214.51	229.99	229.35	212.81	224.05
Mean	10.08	9.21	4.78	8.03	8.57	8.33	6.72	7.87	216.02	209.11	171.17	198.76	210.60	203.13	191.74	201.82

D_1:15:7:16 kgha^{-1}, D_2: 20:12:21 kgha^{-1}, D_3: 25:17:26 kgha^{-1}, D_4: 30:22:31 kgha^{-1}; P_1:15th August, P_2: 1st September, P_3:15th September

fruit length (13.55 cm), yield per plant (2205.1 g) and yield per 1000m^2 (88.21 q) were noticed in 15th Aug planting under nethouse and also lowest yield (32.89 q/1000m^2) was noticed in 15th Sept planting under nethouse. The results revealed that highest fruit weight (216.02 g) was observed in 15th August planting might be due to the warm humid climate in early planting that promoted vigorous growth of the vine leads to increased uptake of applied fertilizers in plants resulted in enhanced chlorophyll synthesis and carbohydrate assimilation resulted in the better development of fruits. The trend of present result is in agreement with the finding of Hamma *et al.* (7) in sweet pepper. The lowest yield noticed under 15th Sept planting, which might be due to coincidence of flowering, fruiting set and development with low temperature which acts as stress to plants which limit the growth and developments of fruits and also under lower temperature plants failed to produce male flower leads to reduced pollination and fruit set of cucurbits resulting in smaller fruit size and lower yield (Todd *et al.,* 14; Yonemori, 15). Among the combinations, 15th Aug sowing with 30:22:31 kg NPKha^{-1} under nethouse showed highest interactions effect for the number of fruits per plant (11.47), fruit weight (235.26 g), yield per plant (2697.7 g) and yield per 1000m^2 (107.91 q).

The effect of different treatments combination on the nutrient content of fruits is presented in Table 6, 7 and 8. Results revealed that protected structures had the significant effect on micronutrient content of the bitter gourd fruit. Among the protected structures, fruits with the highest quantity of nitrogen (152.39 mg/100g), phosphorus (35.33 mg/100g), potassium (318.56 mg/100g), calcium (14.69 mg/100g), iron (0.26 mg/100g), zinc (0.57 mg/100g) and manganese (0.36 mg/100g) were observed under polyhouse. By increasing fertigation level from 15:7:16 kg NPKha^{-1} to 30:22:31 kg NPKha^{-1}, the nutrients content of fruit was increased. Application of 30:22:31 kg NPKha^{-1} resulted fruits with highest amount of nitrogen (229.80 mg/100g), phosphorus (39.33 mg/100g), potassium (343.56 mg/100g), calcium (19.33 mg/100g), iron (0.31 mg/100g) and manganese (0.41 mg/100g) under polyhouse. The present results are corroborated with the findings of Mostafa *et al*. (12) who reported that increasing nitrogen fertigation from 75 to 225 kg/ha has increased N (53.265%), P (77.61%), K (25.85%), Ca (14.28%), Zn (16.58%) and Mn (24.75%) uptake in the fruit. Among the combinations, the highest interaction effect was noticed in 15th Aug planting with 30:22:31 kg NPKha^{-1} for nitrogen (236.10 mg/100g), phosphorus (41.00 mg/100g), potassium (346.33 mg/100g), of calcium (19.33 mg/100g), iron (0.35 mg/100g), zinc (0.64

Table 5. Effect of planting time and fertilizer dose on fruit yield/ plant (g) and Yield /1000 m^2 (q) of bitter gourd var. Pusa Rasdar under polyhouse and nethouse conditions.

Treatments	Fruit yield/plant (g)								Yield/1000m^2 (q)							
	Date of Planting								Date of Planting							
	Nethouse (S1)				Polyhouse (S2)				Nethouse (S1)				Polyhouse (S2)			
(N:P:K)	P1	P2	P3	Mean	P1	P2	P3	Mean	P1	P2	P3	Mean	P1	P2	P3	Mean
D1	1565.4	1475.9	665.31	1235.5	1422.1	1260.5	949.4	1210.7	62.62	59.04	26.61	49.42	56.89	50.42	37.98	48.43
D2	1886.7	1667.4	761.48	1438.5	1710.5	1481.3	1220.2	1470.7	75.47	66.70	30.46	57.54	68.42	59.25	48.81	58.83
D3	2670.6	2305.5	923.05	1966.4	2052.6	2048.9	1495.1	1865.5	106.83	92.22	36.92	78.66	82.11	81.96	59.80	74.62
D4	2697.7	2307.9	938.77	1981.4	2069.9	2048.7	1532.0	1883.5	107.91	92.32	37.55	79.26	82.80	81.95	61.28	75.34
Mean	2205.1	1939.2	822.15	1655.5	1813.8	1709.9	1299.2	1607.6	88.21	77.57	32.89	66.22	72.55	68.40	51.97	64.31

D_1:15:7:16 kgha^{-1}, D_2: 20:12:21 kgha^{-1}, D_3: 25:17:26 kgha^{-1}, D_4: 30:22:31 kgha^{-1}; P_1:15th August, P_2: 1st September, P_3:15th September

Table 6. Effect of planting time and fertilizer dose on nitrogen (N) and phosphorus (P) contents of bitter gourd var. Pusa Rasdar under polyhouse and nethouse conditions.

Treatments	Nitrogen (mg/100g)								Phosphorus (mg/100g)							
	Date of Planting								Date of Planting							
	Nethouse (S1)				Polyhouse (S2)				Nethouse (S1)				Polyhouse (S2)			
(N:P:K)	P1	P2	P3	Mean	P1	P2	P3	Mean	P1	P2	P3	Mean	P1	P2	P3	Mean
D1	95.23	94.13	93.73	94.37	96.57	95.50	95.13	95.73	28.33	28.00	27.00	27.78	32.00	31.00	30.67	31.22
D2	122.23	120.83	117.37	120.14	123.73	122.27	118.67	121.56	32.00	31.00	29.67	30.89	35.33	33.67	33.33	34.11
D3	162.73	159.57	157.00	159.77	163.97	160.87	158.57	161.13	34.67	34.00	33.33	34.00	38.00	36.67	35.33	36.67
D4	234.77	230.77	223.87	229.80	236.10	232.13	225.20	231.14	37.67	36.67	35.67	36.67	41.00	38.00	39.00	39.33
Mean	153.74	151.32	147.99	151.02	155.09	152.69	149.39	152.39	33.17	32.42	31.42	32.33	36.58	34.83	34.58	35.33

D_1:15:7:16 kgha^{-1}, D_2: 20:12:21 kgha^{-1}, D_3: 25:17:26 kgha^{-1}, D_4: 30:22:31 kgha^{-1}; P_1:15th August, P_2: 1st September, P_3:15th September

Table 7. Effect of planting time and fertilizer dose on potassium (K) and calcium (Ca) contents of bitter gourd var. Pusa Rasdar under polyhouse and nethouse conditions.

Treatments	Potassium (mg/100g)								Calcium (mg/100g)							
	Date of Planting								Date of Planting							
	Net house (S1)				Polyhouse (S2)				Net house (S1)				Polyhouse (S2)			
(N:P:K)	P1	P2	P3	Mean	P1	P2	P3	Mean	P1	P2	P3	Mean	P1	P2	P3	Mean
D1	315.33	280.67	276.67	290.89	317.33	283.33	280.00	293.56	10.33	9.67	9.33	9.78	10.67	10.33	10.00	10.33
D2	315.00	310.33	298.33	307.89	316.67	313.33	299.67	309.89	12.33	12.00	12.33	12.22	13.00	12.67	13.00	12.89
D3	334.33	327.67	312.00	324.67	336.33	330.00	315.33	327.22	15.33	15.00	15.33	15.22	16.67	15.67	16.33	16.22
D4	345.33	340.33	338.00	341.22	346.33	343.67	340.67	343.56	18.67	18.33	18.67	18.56	19.33	19.33	19.33	19.33
Mean	327.50	314.75	306.25	316.17	329.17	317.58	308.92	318.56	14.17	13.75	13.92	13.94	14.92	14.50	14.67	14.69

D_1:15:7:16 kgha^{-1}, D_2: 20:12:21 kgha^{-1}, D_3: 25:17:26 kgha^{-1}, D_4: 30:22:31 kgha^{-1}; P_1:15th August, P_2: 1st September, P_3:15th September

Table 8: Effect of planting time and fertilizer dose on iron (Fe) and zinc (Zn) contents of bitter gourd var. Pusa Rasdar under polyhouse and nethouse conditions.

Treatments	Iron (mg/100g)								Zinc (mg/100g)							
	Date of Planting								Date of Planting							
	Nethouse (S1)				Polyhouse (S2)				Nethouse (S1)				Polyhouse (S2)			
(N:P:K)	P1	P2	P3	Mean	P1	P2	P3	Mean	P1	P2	P3	Mean	P1	P2	P3	Mean
D1	0.18	0.17	0.18	0.18	0.21	0.20	0.20	0.21	0.50	0.49	0.51	0.50	0.52	0.51	0.53	0.52
D2	0.21	0.21	0.22	0.21	0.24	0.24	0.23	0.24	0.55	0.54	0.55	0.55	0.57	0.56	0.57	0.57
D3	0.24	0.25	0.25	0.25	0.26	0.27	0.28	0.27	0.57	0.57	0.57	0.57	0.59	0.59	0.59	0.59
D4	0.29	0.28	0.28	0.29	0.32	0.31	0.30	0.31	0.62	0.62	0.62	0.62	0.64	0.49	0.64	0.59
Mean	0.23	0.23	0.23	0.23	0.26	0.26	0.25	0.26	0.56	0.55	0.56	0.56	0.58	0.54	0.58	0.57

D_1:15:7:16 kgha^{-1}, D_2: 20:12:21 kgha^{-1}, D_3: 25:17:26 kgha^{-1}, D_4: 30:22:31 kgha^{-1}; P_1:15th August, P_2: 1st September, P_3:15th September

Table 9: Critical difference (CD) at 5% for growth, yield and nutritional characters of bitter gourd var. Pusa Rasdar under polyhouse and nethouse conditions

Source	CD at 5%																
	Days to first male flower	Days to first female flower	Node of first male flower	Node of first female flower	Fruit length	Fruit diameter	Number of fruits	Fruit weight	Yield/ plant	Yield/ 1000 m^2	N	P	K	Ca	Fe	Zn	Mn
S	NS	NS	NS	0.18	NS	NS	0.13	0.92	25.43	1.02	NS	0.54	NS	0.49	0.00	NS	0.00
P	0.37	0.51	NS	0.22	NS	0.09	0.16	1.12	31.14	1.25	1.94	0.66	9.15	NS	NS	NS	0.02
D	NS	NS	NS	NS	0.27	0.11	0.18	1.30	35.96	1.44	2.25	0.76	10.57	0.69	0.01	0.03	0.01
S × P	0.52	0.72	NS	0.32	0.33	0.13	0.23	1.59	44.04	1.76	NS	NS	NS	NS	NS	NS	NS
S × D	NS	NS	NS	NS	0.46	0.19	0.32	2.25	62.28	2.49	NS	NS	NS	NS	NS	NS	NS
P × D	NS	NS	NS	NS	0.38	0.15	0.26	1.84	50.85	2.03	NS	NS	NS	NS	0.01	NS	NS
S × P × D	NS	NS	NS	0.64	0.65	0.27	0.45	3.18	88.08	3.52	NS	NS	NS	NS	NS	NS	NS

S: Protected structures; P: Date of plantings; D: Fertilizer doses; NS: Non-significant

mg/100g) and manganese (0.42 mg/100g) content of bitter gourd under polyhouse. There was no observable significant difference between planting dates for nutrients content of the fruit.

In conclusion, 15th August planting with the application of 30:22:31 kg NPK ha^{-1} has a beneficial effect on the fruit yield and nutrients content of the bitter gourd. Based on these findings, it is recommended that the cultivation of bitter gourd var. Pusa Rasdar at 15th August planting with application of 30:22:31 kg NPKha^{-1} under the insect-proof nethouse for the successful plant growth, economic yield and quality.

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