Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(3): 462-465
Received: 22-03-2020
Accepted: 26-04-2020

P Ahmed
Department of Agronomy, SCS College of Agriculture, Assam Agricultural University, Dhubri, Rangamati, Assam, India

M Saikia
Directorate of Research (Agri), Assam Agricultural University, Jorhat, Assam, India

K Pathak
Directorate of Research (Agri), Assam Agricultural University, Jorhat, Assam, India

S Dutta
Department of Soil Science, College of Agriculture, AAU, Jorhat, Assam, India

AC Sarmah
Regional Agricultural Research Station, Assam Agricultural University, Shillongani, Nagaon, Assam, India

Corresponding Author:
P Ahmed
Department of Agronomy, SCS College of Agriculture, Assam Agricultural University, Dhubri, Rangamati, Assam, India

Effect of date of sowing and nitrogen management on yield, nitrogen uptake and soil-nitrogen balance in rice-green gram-maize crop sequence under rainfed condition in Assam

P Ahmed, M Saikia, K Pathak, S Dutta and AC Sarmah

Abstract
A field experiment was conducted at the farm of Krishi Vigyan Kendra, Tinsukia, Assam during 2016-17 and 2017-18, to study the effect of sowing dates and N management practices on yield, N uptake and soil-nitrogen balance in rice-green gram-maize crop sequences under rainfed upland conditions. The experiment was laid out in factorial RBD with three replications. The treatment consisted of four date of sowings and N management. Results revealed that all the three crops sown early had shown significantly higher grain yield and N uptake than the crops sown late. Application of 50% N as inorganic along with vermicompost @ 1.0 t/ha resulted significantly higher grain yield and N uptake as compared to other N management practices. Moreover, application of 50% N as inorganic along with vermicompost @ 1.0 t/ha registered the highest net gain in soil available N irrespective of sowing dates at the end of two years of cropping sequence.

Keywords: Crop sequence, nitrogen management, nitrogen balance, sowing date, yield

Introduction
In Assam, rice is the dominant crop covering about 24.84 lakh ha with a production of 51.25 lakh MT and productivity of 20.87 q/ha during 2015-16. Though *sali* rice (winter rice) is the predominant crop of the state, a considerable rice area (10%) is presently occupied by the *ahu* rice (autumn rice) with a production of 2.56 lakh MT (Anonymous, 2017) [1]. During autumn season, the crop is mainly grown as rainfed in both upland and medium low land situations with or without irrigation. This ecosystem of the state is suitable for growing of two or more crops in sequence and many farmers grow different crops after rice depending on the available resources. Inclusion of a legume (green gram/black gram) in a rice-based cropping system not only helps in improving economic return but also improves the soil health. Maize is one of the most versatile emerging cereal cash crop having wider adaptability under varied agro-climatic conditions. The ability of the maize crop to grow in different seasons and high productivity of *rabi*/winter season give it added advantages for inclusion in the cropping system as demand for more food grows.

While intensive agriculture, involving exhaustive high yielding varieties of crops in cropping sequence has led to heavy withdrawal of nutrients from the soil, imbalanced and indiscriminate use of chemical fertilizers has resulted in deterioration of soil health in the marginal soils. There is immense need to exploit the alternate source of nutrients particularly nitrogen *viz*., vermicompost, use of legumes in crop rotation and bio fertilizer to sustain the productivity with more environment friendly nutrient management system. There is also need to shift sowing dates to accommodate the crops in most favourable microclimatic conditions in three crop sequence. Balance-sheet of major nutrients like nitrogen in the soil could be used for the judicious application of nutrients to crop sequences. Keeping these points in view, an experiment was conducted to assess yield, N uptake and soil nitrogen balance under different sowing dates and nitrogen management practices in rice-green gram-maize crop sequence in the Tinsukia district of Assam.

Materials and Methods
The field experiments were conducted at KVK, Tinsukia during *summer*, *kharif* and *rabi* seasons of 2016-17 and 2017-18 with rice-green gram-maize cropping sequences. The soil was sandy clay loam with pH of 5.12 and 5.23, high in organic carbon 0.85% and 0.90%, medium in available N (298.75 kg/ha and 310.45 kg/ha) and available P_2O_5 (25.92 kg/ha and 26.13 kg/ha) and very low in available K_2O (33.5 kg/ha and 34.4 kg/ha) at the start of the experiment

during 2016-17 and 2017-18, respectively. The experiment was laid out in factorial RBD with 3 replications. The treatments consisted of four dates of sowing, i.e., (1 April - D_1, 15 April - D $_2$, 1 May - D $_3$, 15 May - D $_4$ for rice; 15 August - D $_1$, 1 September - D $_2$, 15 September - D $_3$, 1 October - D_4 for green gram and 1 November - D $_1$, 15 November - D_2, 1 December - D_3, 15 December - D_4 for maize) and nitrogen management (N_1: 100% RDF of N as inorganic; N_2: 75% N as inorganic + 0.5 t/ha vermicompost (V.C.); N_3: 50% N as inorganic + 1.0 t/ha V.C., N_4: 25% N as inorganic + 1.5 t/ha V.C.). The 1st crop rice was fertilized with application of N, P_2O_5 and K_2O @ 40:20:20 kg/ha, respectively. Full dose of P_2O_5 and K_2O and 1/3rd dose of N were applied just before sowing as per the treatments. Remaining 2/3rd dose of N were top dressed in two equal splits at 20-25 days and 40-45 days after sowing. The 2nd crop green gram was fertilized with a uniform dose of N, P_2O_5 and K_2O @ 10:35:10 kg/ha, respectively. Full dose of N, P_2O_5 and K_2O were applied at the time of sowing as per the treatments. Maize, the 3rd crop was fertilized with application of N, P_2O_5 and K_2O @ 60:40:40 kg/ha, respectively. Full dose of P_2O_5 and K_2O and 1/3rd dose of N were applied at the time of sowing as per the treatments. Remaining 2/3rd dose of N were applied in two equal splits at knee height and before tasseling stage. Vermicompost were incubated with *Azotobacter* and phosphorous solubilizing bacteria (PSB) in rice and maize and *Rhizobium* and PSB in green gram for 15 days @ 0.2% (w/w) and incubated vermicompost were applied at a specified rate as per the treatments. Rice (variety 'Inglongkiri') were sown as direct seeding method in lines with an inter-row spacing of 20 cm @ 75 kg/ha. Green gram (variety 'SG-1') seeds were inoculated with *rhizobium* culture and were sown @ 22 kg of seed/ha in lines by maintaining a spacing of 30 cm × 10 cm. Maize (variety 'Vivek 45'**)** seed @ 22.5 kg/ha were sown in lines by maintaining a spacing of 60 cm × 25 cm. Other agronomic management practices and plant protection measures were followed as per the recommendation. Data on yield of all the three crops was recorded from net plot size of 3.6 m × 3.6 m. The plant samples were dried, processed and analyzed for N content (Jackson, 1973) [7]. N uptake was calculated from data on concentration (%) of nitrogen multiplied by the corresponding dry matter yield. Soil samples were analyzed at initial and after completion of the studies for available N (Subbiah and Asija, 1956) [17]. The nitrogen balance-sheet of the soil was worked out by adopting the method suggested by Palaniappan (1985) [11]. Subtraction of the total quantity of nitrogen removed by the crops in a sequence from that added by fertilizers and soil gave the computed balance of soil nitrogen. The actual balance of nitrogen is indicated by the available nitrogen status of the soil. The balance-sheet of nitrogen was arrived at by subtracting the computed balance from the actual balance. The data of both the years were analyzed statistically as per standard procedure described by Panse and Sukhatme (1985) [12].

Results and Discussion

Yield and N uptake: In rice, 1st crop of the sequence, the grain yield and N uptake was significantly influenced by date of sowings and nitrogen management in both the years (Table1). Results indicated that the crop sown on 1 April (D_1) resulted in significantly higher grain yield as compared to other sowing dates and it decreased gradually with subsequent delay in sowing in both the years. The crop sown on 1 April (D_1) recorded highest grain yield whereas the lowest grain yield was recorded in 15 May (D_4). The decreasing trend due to delayed sowing might be associated with lower number of productive tillers/m^2, less number of filled grains/panicle and low 1000-grain weight. The higher paddy yield in 1 April sown crop might be due to more number of productive tillers, more number of grains/panicle and increased 1000 - grain weight. These results are in line with finding of Dahiya *et al.* (2017) [4] pointing out that early sowing dates resulted in the maximum number of panicle/m^2, total florets/panicle, 1000-grain weight and paddy yield compared to delayed sowing.

Application of 50% N as inorganic + 1.0 t/ha V.C. (N_3) recorded significantly higher grain yield as compared to other nitrogen treatments. The highest grain yield of 29.52 q/ha and 28.30 q/ha was recorded in 50% N as inorganic + 1.0 t/ha V.C. (N_3) in 2016-17 and 2017-18, respectively. These results were in conformity with Dekhane *et al*. (2014) [6]. They reported that application of 50% N through RDF + 50% N through vermicompost recorded higher growth and yield attributes of rice variety GR 11 as compared to 100% RDF and 75% RD of NPK through inorganic + 25% through vermicompost.

Similarly the crop sown on 1 April recorded higher N uptake during 2016-17 and 2017-18, respectively which was significantly higher than other sowing dates. On the other hand, the lower N uptake was recorded in 15 May sown crops. The higher N uptake in the crop sown on 1 April might be due to the higher N concentration and grain as well as straw yield.

Application of 50% N as inorganic + 1.0 t/ha V.C resulted in significantly higher N uptake as compared to other nitrogen management. The higher N uptake in 50% N as inorganic + 1.0 t/ha V.C might be due to higher N concentration and yield of the crop. These results were in conformity with Kaushal *et al*. (2010) [8]. They reported nitrogen uptake by crop, a function of total biomass produced and percent nitrogen concentration in the biomass. Higher N uptakes due to integrated nutrient management with 50 per cent N through inorganic fertilizer + 50% N through vermicompost were also reported by Venkatesha *et al*. (2015) [18].

In green gram, 2nd crop of the sequence, the seed yield and N uptake was significantly influenced by date of sowing and nitrogen management in both the years (Table 1). The crop sown on 1 September (D_2) resulted in significantly higher seed yield (8.57 q/ha) over other sowing dates but was statistically at par with 15 August (D_1) with seed yield of 8.45 q/ha in 2016-17. In 2017-18, significantly higher seed yield (8.10 q/ha) was recorded in 15 August sowing crop which was statistically at par with the seed yield of 7.98 q/ha in 1 September sowing crop. Higher seed yield realized in case of 15 August or 1 September sown crop because of higher no of pods/plant and no of seeds/pod associated with greater sink. It was observed that the seed yield decreased gradually with delay in sowing time in both the years of study. Under late sown condition, plants, however, could not accumulate the sufficient phosynthesis due to poor vegetative growth (Singh *et al*., 2010) [15].

Amongst nitrogen management, the highest seed yield was observed with application of 50% N as inorganic + 1.0 t/ha V.C which was significantly higher compared to other nitrogen treatment. The combined application of inorganic and organic sources of nitrogen enhanced the availability of the nutrients to the plants and this might have resulted in profuse shoot and root growth and thereby activating greater absorption of the nutrients from soil and improved the growth, yield attributes and finally seed yield of green gram. The results were in conformity with Kumar *et al*., (2015) [9].

In both years, the crop sown on 15 August recorded significantly higher N uptake compared to other date of sowing. Moreover, N uptake by the crop sown on 15 August was statistically at par with N uptake by the crop sown on 1 September. The highest N uptake by the crop sown on 15 August might be due to the higher nutrient concentration, seed as well as stover yield. Similar results were also reported by Singh *et al.* (2014) [16]. They reported that the uptake of N, P and K by seed, straw as well as total produce of mungbean was significantly higher under June 25th sown crop as compared to delayed sowing dates. Since uptake is a product of nutrient concentration and yield hence, higher yield (seed + straw) under June 25th sown crop might have increased the total N, P and K uptake.

Application of 50% N as inorganic + 1.0 t/ha V.C recorded maximum N uptake, which was significantly higher compared to other nitrogen management practices. This might be due to balanced supply of nutrients which favoured the root proliferation by stimulating cellular activities and translocation of certain growth stimulating compounds to roots. Thus, the extensive root system development with balanced fertilization along with organic in adequate amount would have assisted the efficient absorption and utilization of other nutrient (Kumar *et al*., 2015) [9]. Since uptake of nutrients is a function of their content and yield, increase in seed and stover yield along with higher content of nitrogen might have resulted in higher uptake of nitrogen in the crop.

In maize, 3rd crop of the sequence, grain yield and N uptake differed significantly due to date of sowing and nitrogen management in both the years (Table 1). The data pertaining to grain yield revealed that the crop sown on 1 November (D_1) showed significantly superior over other date of sowing. During both the years, the highest grain yield (33.18 q/ha and 31.09 q/ha) was recorded in 1 November (D_1) sowing whereas the lowest grain yield (25.42 q/ha and 25.40 q/ha) was recorded in 15 December (D_4) sowing, respectively. Highest grain yield in early sown crop (1 November) might be due to higher grain weight/cob and 1000-grain weight. The results are in accordance with Casini (2012) [3] who reported significant differences among planting dates for ear/plant and grain yield of maize. It was also observed that the latest date of sowing, when compared to first, showed a reduction in ear/plant (-20%). Similarly, grain yield of the cultivar decreased significantly as the sowing date was delayed. Sen *et al*. (2000) [13] also reported decreased grain yield due to delay in sowing time in maize. Application of 50% N as inorganic + 1.0 t/ha V.C. (N_3) recorded significantly higher grain yield (30.64 q/ha and 31.45 q/ha) compared to other nitrogen management during 2016-17 and 2017-18, respectively. Combined application of both sources of nutrient might have resulted in better availability of nutrients throughout the crop growth period. This resulted in higher yield attributes and ultimately higher grain yield. Similar results were also observed by Nagavani and Subbian (2014) [10].

The crop sown on 1 November recorded significantly higher N uptake compared to other date of sowing. This might be due to the higher nutrient concentration and grain as well as stover yield. Similarly the treatment receiving 50% N as inorganic + 1.0 t/ha V.C recorded maximum N uptake, which was significantly higher compared to other nitrogen treatments. This might be due to higher N concentration and yield of the crop. These results were in conformity with Shivaran *et al.* (2015) [14]. They reported that content of N in cob and fodder as well as uptake of N by cob and fodder at harvest increased with the application of 75.0 per cent N through fertilizer and 25.0 per cent N through vermicompost. The significant improvement in uptake of N might be attributed to their concentration in cob and fodder and associated with higher green cob and fodder yield.

Balance sheet of available nitrogen:

Balance sheet of available nitrogen in soil at the end of 2 years of cropping sequence (Table 2) clearly indicated that irrespective of date of sowing of the component crops, application of 50% N as inorganic + 1.0 t/ha V.C. registered the highest net gain in available N in soil, which accounts 234.59 kg/ha and 218.00 kg/ha, 193.48 kg and 189.24 kg/ha, 177.56 kg/ha and 176.63 kg/ha and 156.31 kg/ha and 152.57 kg/ha, respectively compared to other nitrogen treatments during 2016-17 and 2017-18, respectively. Crop rotations with legumes and integration of nutrient sources improve the multiplication of microbes, which could convert the organically bound nitrogen to inorganic forms that reflected higher net gain in available N (Das *et al*., 2004) [5]. Bera and Ghosh (2012) [2] also reported maximum N balance in the treatment receiving 40% recommended N + 20% N through neem cake + 40% N through weed compost + full PK (+335.20 kg/ha) in green gram-rice-onion cropping sequence.

Table 1: Yield and N uptake in component crops of the system as influenced by date of sowing and nitrogen management

Treatments	Yield (q/ha)						N uptake (kg/ha)					
	Rice		Green gram		Maize		Rice		Green gram		Maize	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Date of sowing (D)												
D_1	31.18	29.88	8.45	8.10	33.18	31.09	81.56	83.62	50.18	51.49	128.86	121.44
D_2	28.10	26.78	8.57	7.98	29.78	28.16	74.79	75.56	49.99	50.80	118.28	113.10
D_3	27.14	26.08	7.89	6.97	25.73	27.07	72.78	73.35	45.57	44.17	108.76	110.26
D_4	24.58	23.70	6.45	6.71	25.42	25.40	65.83	66.67	38.16	40.64	97.49	99.37
S.Em.(±)	0.26	0.21	0.06	0.04	0.24	0.21	0.48	0.50	0.33	0.26	0.75	0.72
CD (0.05)	0.75	0.61	0.17	0.13	0.69	0.61	1.39	1.45	0.94	0.75	2.18	2.09
Nitrogen management(N)												
N_1	27.59	26.18	8.07	7.44	28.09	27.36	68.00	69.94	45.80	45.43	107.01	104.79
N_2	28.63	27.87	8.01	7.71	29.42	28.74	78.58	79.89	47.54	48.51	117.81	115.65
N_3	29.52	28.30	8.48	7.72	30.64	31.45	81.07	81.84	50.91	51.35	127.38	126.83
N_4	25.26	24.09	6.81	6.90	25.96	24.17	67.49	67.53	39.77	41.93	101.20	96.91
S.Em.(±)	0.26	0.21	0.06	0.04	0.24	0.21	0.48	0.50	0.33	0.26	0.75	0.72
CD (0.05)	0.75	0.61	0.17	0.13	0.69	0.61	1.39	1.45	0.94	0.75	2.18	2.09

D_1 - Rice (1 April), Green gram (15 August), Maize (1 November); D_2 - Rice (15 April), Green gram (1 September), Maize (15 November); D_3 - Rice (1 May), Green gram (15 September), Maize (1 December); D_4 - Rice (15 May), Green gram (1 October), Maize (15 December)

N_1: 100% N as Inorganic; N_2: 75% N + 0.5 t/ha V.C.; N_3: 50% N + 1.0 t/ha V.C.; N_4: 25% N + 1.5 t/ha V.C.

Table 2: Balance - sheet of available nitrogen (kg/ha) in soil as influenced by date of sowing and nitrogen management

Treatment combinations	Initial N (kg/ha)		Applied N (kg/ha)		Total available of N (kg/ha)		Removal of N (kg/ha)		Computed balance (kg/ha)		Actual Balance (kg/ha)		Net gain in N (kg/ha)	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
$D_1 N_1$	298.75	310.45	110.0	110.0	408.75	420.45	240.68	243.33	168.07	177.12	306.20	326.12	138.13	149.00
$D_1 N_2$	298.75	310.45	110.0	110.0	408.75	420.45	275.15	271.23	133.60	149.22	353.71	358.27	220.11	209.05
$D_1 N_3$	298.75	310.45	110.0	110.0	408.75	420.45	296.60	286.72	112.15	133.73	346.74	351.73	234.59	218.00
$D_1 N_4$	298.75	310.45	110.0	110.0	408.75	420.45	231.06	225.69	177.69	194.76	340.85	346.73	163.16	151.97
$D_2 N_1$	298.75	310.45	110.0	110.0	408.75	420.45	236.79	222.36	171.96	198.09	316.49	317.61	144.53	119.52
$D_2 N_2$	298.75	310.45	110.0	110.0	408.75	420.45	253.44	254.76	155.31	165.69	340.69	350.26	185.38	184.57
$D_2 N_3$	298.75	310.45	110.0	110.0	408.75	420.45	260.74	259.81	148.01	160.64	341.49	349.88	193.48	189.24
$D_2 N_4$	298.75	310.45	110.0	110.0	408.75	420.45	222.06	218.86	186.69	201.59	333.94	347.46	147.25	145.87
$D_3 N_1$	298.75	310.45	110.0	110.0	408.75	420.45	212.20	216.05	196.55	204.40	298.50	298.50	101.95	94.10
$D_3 N_2$	298.75	310.45	110.0	110.0	408.75	420.45	234.71	234.43	174.04	186.02	336.59	348.73	162.55	162.71
$D_3 N_3$	298.75	310.45	110.0	110.0	408.75	420.45	245.65	247.67	163.10	172.78	340.66	349.41	177.56	176.63
$D_3 N_4$	298.75	310.45	110.0	110.0	408.75	420.45	215.94	212.98	192.81	207.47	341.23	344.45	148.42	136.98
$D_4 N_1$	298.75	310.45	110.0	110.0	408.75	420.45	193.45	198.97	215.30	221.48	324.73	331.48	109.43	110.00
$D_4 N_2$	298.75	310.45	110.0	110.0	408.75	420.45	217.73	221.65	191.02	198.80	314.67	334.20	123.65	135.40
$D_4 N_3$	298.75	310.45	110.0	110.0	408.75	420.45	229.69	237.65	179.06	182.80	335.37	335.37	156.31	152.57
$D_4 N_4$	298.75	310.45	110.0	110.0	408.75	420.45	165.51	169.42	243.24	251.03	337.33	337.33	94.09	86.30

D_1 - Rice (1 April), Green gram (15 August), Maize (1 November); D_2 - Rice (15 April), Green gram (1 September), Maize (15 November); D_3 - Rice (1 May), Green gram (15 September), Maize (1 December); D_4 - Rice (15 May), Green gram (1 October), Maize (15 December)
N_1: 100% N as Inorganic; N_2: 75% N + 0.5 t/ha V.C.; N_3: 50% N + 1.0 t/ha V.C.; N_4: 25% N + 1.5 t/ha V.C.

Conclusion

Based on two years of study, it may be concluded that there is possibility of shifting the dates of sowing of component crops in a rice-based cropping sequence and as such early date of sowing for rice, green gram and maize along with application of 50% N as inorganic + 1.0 t/ha V.C. may be suggested for higher yield, nitrogen uptake and making soil richer in available nitrogen under the agro-climatic condition of Assam.

References

1. Anonymous. Economic survey of Assam 2017-18, Transformation and Development Department, Directorate of Economics and Statistics, Govt. of Assam, 2017.
2. Bera S, Ghosh RK. Effect of integrated weed and nutrient management in green gram-rice-onion cropping sequence on yield and nitrogen balance sheet. Journal of Crop and Weed. 2012; 9(2):159-164.
3. Casini P. Maize production as affected by sowing date, plant density and row spacing in the Bolivian Amazon. Journal of Agriculture and Environment for International Development. 2012; 106(2):75-84.
4. Dahiya S, Punia SS, Singh J, Kakraliya SK, Singh B, Jat HS *et al*. Yield and yield attributes as affected by different sowing dates and different maturity classes cultivar on direct seeded rice. Chemical Science review and letters. 2017; 6(21):149-152.
5. Das A, Prasad M, Gautam RC. Residual effect of organic and inorganic sources of nitrogen applied to cotton on succeeding wheat. Indian Journal of Agronomy. 2004; 49(3):143-146.
6. Dekhane SS, Patel DJ, Jadhav PB, Kireeti A, Patil NB, Harad NB *et al*. Effect of organic and inorganic fertilizer on growth and yield of paddy cv. GR 11. International Journal of Information Research and Review. 2014; 1(2):026-028.
7. Jackson ML. Soil chemical analysis. Prentice Hall of India Pvt. Ltd. New Delhi, 1973.
8. Kaushal AK, Rana NS, Singh A, Sachin N, Srivastav A. Response of levels and split application of nitrogen in green manured wetland rice (*Oryza sativa* L.). Asian Journal of Agricultural Sciences. 2010; 2(2):42-46.
9. Kumar R, Deka BC, Ngachan SV. Response of summer mungbean to sowing time, seed rates and integrated nutrient management. Legume Research. 2015; 38(3):348-352.
10. Nagavani AV, Subbian P. Productivity and economics of hybrid maize as influenced by integrated nutrient management. Current Biotica. 2014; 7(4):283-293.
11. Palaniappan SP. Cropping Systems in the Tropics: Principles and Management. Wiley Eastern Ltd, New Delhi, 1985.
12. Panse VG, Sukhatme PV. Statistical Methods for Agriculture Workers, Indian Council of Agricultural Research, New Delhi, 1985.
13. Sen A, Singh SC, Sharma SN, Singh AK, Singh R, Pal AK. Agronomy of maize inbred parental line. Indian Farming. 2000; 50(6):18-20 & 30.
14. Shivaran A, Mathukia RK, Takar SS, Bijarniya AL, Kudi RK. Effect of fertility levels and fertilizer: vermicompost proportions on yield, content and uptake of nutrients and economics of baby corn (*Zea mays*). Journal of Eco-friendly Agriculture. 2015; 10(1): 36-38.
15. Singh G, Sekhon HS, Ram H, Gill KK, Sharma P. Effect of date of sowing on nodulation, growth, thermal requirement and grain yield of *kharif* mung bean genotypes. Journal of Food Legumes. 2010; 23(2):132-134.
16. Singh M, Rana, NS, Prakash S, Singh A, Dhyani BP. Growth and yield behaviour of mungbean genotype (*Vigna radiata* L.) under different dates of sowing and effect on soil health. Agriways. 2014; 2(1):28-34.
17. Subbiah BV, Asija GL. A rapid procedure for the determination of available nitrogen in soils. Current Science. 1956; 25:259-260.
18. Venkatesha MM, Krishnamurthy N, Tuppad GB, Venkatesh KT. Yield, economics and nutrient uptake of aerobic rice cultivars as influenced by INM practices. Research in Environment and Life Sciences. 2015; 8(1):113-118.