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EFFECT OF NITROGEN FERTILIZER ON THE GROWTH OF MUNGBEAN [*VIGNA RADIATA* (L.) WILCZEK] GROWN IN QUETTA

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Abstract

The objective of the study was to evaluate the growth respose of mungbean [*Vigna radiata* (L.) Wilczek] cultivars subjected to different levels of applied N fertilizer. To achieve the aim, an experiment conducted in the experimental field of Agricultural Research Institute (ARI), Quetta. The soil of the study area was basic in reaction, salt free, medium textured having low organic matter & total N contents. Four different cultivars of mungbean viz., NM-92, NM-98, M-1, and NCM-209 grown in kharif season for two consecutive years i.e., 2007 and 2008. Six different levels of N fertilizer applied @ zero, 20, 40, 60, 80 and 100 kg ha^{-1}. While, a constant dose of P_2O_5 and K_2O also applied to each N level (except control, zero). Urea fertilizer used as a source of N, while TSP and SOP as sources of P & K, respectively. The plot size kept as 2.40m^2 (4x4x0.15), and arranged in a randomized complete block design (RCBD). Results showed that different fertilizer levels did significantly ($p<0.05$) influenced most of the growth attributes of the mungbean. Maximum days to flowering (48.25) and number of branches plant^{-1} (3.83) recorded for plants subjected to highest dose of applied N fertilizer viz., 100 kg ha^{-1}. Similar responses toward added N fertilizer also noted for various cultivars of mungbean. Maximum days to flowering (47.72) and number of leaves plant^{-1} (5.86) recorded for NCM-209. Whereas, the maximum plant height (38.52 cm) number of branches plant^{-1} (3.72) obtained for mungbean cultivar M-1. The correlation coefficient (r) studies exibited that plant height (0.593), number of leaves plant^{-1} (r=0.325), number of branches plant^{-1} (r=0.187) and leaf area (r=0.342) significantly ($p<0.05$) and positively correlated with their grain yield (kg ha^{-1}). However, days to 50% flowering (r=-0.265) are also significantly but negatively associated with their grain yield (kg ha^{-1}). Thus based on correlation studies it could revealed that cultivars under cultivation displayed a wide range of variation for most of the mentioned growth traits and could be exploited in breeding programme to enrich the mungbean genetic treasure.

Introduction

Mungbean [*Vigna radiata* (L.) Wilczek] is an important legume and short duration pulse crop of Pakistan and other South Asian Countries. It is highly prized for its rich protein contents (24%) with excellent digestibility as compared with urdbean and soybean (Chitra *et al.,* 1995; Sarwar *et al.,* 2004). It is rich in essential amino acids especially lysine, which is deficient in most of the cereal grains (Malik, 1994). It uses as fodder for livestock as well as green manure (Brounce, 2002; Kaprelynts *et al*., 2003; Sarwar *et al.,* 2004). It also contains 1-3% fat, 50.4% carbohydrates, 3.5-4.5% fibers and 4.5-5.5% ash, while calcium and phosphorus are 132 and 367 mg per 100 grams of seed, respectively (Phoehlman, 1991; Abd El-Lateef, 1993; Hirota *et al.,* 1995; Frauque *et al.,* 2000). Mungbean is one of the most important conventional and major kharif crop grown in Pakistan (Khattak *et al.,* 2004a,b). This crop has grown over an area of 217.7 thousands hectares with an annual production of 138.4 thousand tonnes and produced an average yield of 636 kg ha^{-1} (Anon., 2006-07).

In Pakistan during year mungbean is grown over an area of 219.7 thousand hectates with a total production of 157.4 tones making an average of 716 kg ha^{-1}. Though mungbean is growing all over the country, but Punjab is the major mash producing province (Anon., 2008-09a). Balochistan is one of the four provinces of Pakistan by far the largest (44%) in total area of the country and the smallest in number of inhabitants (Anon., 1983). Based upon climate, soil and topography, province has divided into 5 ecological zones. The present field area i.e., Quetta falls in zone 4, a region with Mediterranian climate, having latitude 30º21´N, and longitude 67º1´12´E (Anees, 1980). In Balochistan the crop is growing on an area of 11,406 hectares with total production of 6,945 tones making an average of 609 kg ha^{-1} (Anon., 2008-09b). The average grain yield of mungbean in Pakistan is very low or marginal as compared to its potential yield i.e., 1295 kg ha^{-1} (Bilal, 1994). The substandard methods of cultivation, poor crop stand, imbalanced nutrition or no fertilizer application, poor plant protection measures, and lack of high yielding varieties are the main inhibitors. The management of fertilizer is the important one that greatly affects the growth attributes and yield of this crop. Pulses although fix atmospheric N_2 by symbiotic means, but application of nitrogenous fertilizer as starter or initial dose becomes helpful in increasing the growth and yield of legume crops (Ardeshana *et al.,* 1993). Nitrogen is most useful for pulse crops because it is a major component of protein (Anon., 2005). Being a drought tolerant crop, mungbean is mostly growing in rainfed areas of the country where yield level is very low. Another important reason of its lower productivity is lack of cultivars with high yield potentials.

Research revealed that mungbean yield and quality could improved by the use of balanced fertilizers (Choudhry, 2005; Aslam *et al*., 2010). Salah Uddin *et al.,* (2009) stated that most of the growth components significantly influenced by chemical and biofertilizers. Abbas (1994) reported that application of NPK @ 25-50-75 kg ha^{-1} gave the highest grain yield of 1666 kg ha^{-1}. Studies also reported that grain yield of mungbean was increased by the application of 20 kg N and 40 kg P_2O_5 whereas K application showed non-significant effects (Singh *et al*., 1993). Khan *et al.,* (1999) reported that phosphorus application significantly increased the yield of mungbean. Many other researchers also reported that grain yield of legumes increased with increasing P_2O_5 upto 50 kg ha^{-1} (Thakuria & Saharia, 1990; Patel & Patel, 1991; Rajkhowa *et al.,* 1992; Chovatia *et al.,* 1993). Whereas, Tariq *et al.,* (2001) stated that application of P_2O_5 and K_2O each @ 70 kg ha^{-1} alongwith N application @ 30 kg ha^{-1} produced the highest grain yield. The maximum seed yield i.e., 224.2 g m^{-2} was obtained when 90 kg N and 120 kg P_2O_5 ha^{-1} was applied (Sadeghipour *et al.,* 2010). The maximum number of pods $plant^{-1}$ (20.87), pods length (8.71 cm), seeds pod^{-1} (8.53), 1000 seeds (27.82 g) and seed yield (1.40 t ha^{-1}) obtained in fertilizer application @ 45:80:55 kg NPK ha^{-1} + *Rhizobium* inoculation (Hossain *et al.,* 2011). A very little is known about the mungbean response in term of growth attributes toward applied NPK fertilizers. Therefore, the objectives of the present study were to investigate the extent of maximum dose of fertilizer application and to pinpoint that cultivar of mungbean, which are promising in term of growth attributes. The study also aimed to establish a relationship between various growth parameters and grain yield to identify a set of growth traits to be used in future breeding programme of mungbean cultivars.

Materials and Methods

The present study was carried out at the experimental field of Directorate of Fodder, Pulses & Special Crops, ARI, Quetta, Pakistan during kharif for two consecutive years i.e., 2007 & 2008. Experiments laid out in Randomized Complete Block Design (RCBD) having factorial arrangement with three replications. Net plot size was 2.40m^2 (4x4x0.15). The certified seeds of four different cultivars of mungbean viz., NM-92, NM-98, M-1, and NCM-209 used for this study, and fertilizer treatments applied as follows:-

T1	=	No fertilizer (control)
T2	=	20 + 50 + 30 kg NPK ha^{-1}
T3	=	40 + 50 + 30 kg NPK ha^{-1}
T4	=	60 + 50 + 30 kg NPK ha^{-1}
T5	=	80 + 50 + 30 kg NPK ha^{-1}
T6	=	100 + 50 + 30 kg NPK ha^{-1}

The crop sown during the first fortnight of July and harvested during the 2nd week of October each year. The seed rates maintained as 20 kg ha^{-1} with single row hand drill in 15cm apart rows, and 30 cm distance between cultivars. A basal dose of phosphorus and potassium (50+30 kg PK ha^{-1}) alongwith aforementioned prescribe doses of nitrogen was applied at first irrigation in the form of urea, TSP and SOP, respectively. Before physiological maturity, five plants from each cultivar selected at random for recording the days to 50% flowering, days to maturity, number of leaves $plant^{-1}$, plant height (cm), number of branches $plant^{-1}$, and leaf area (cm^2). A composite soil sample from both year fields with the help of soil auger also taken at a depth of 0-15, 16-30 and 31-45cm (before sowing & fertilizer application). Then they analyzed for their physicochemical characteristics following the procedure described by Anonymous (1953). The soil of the study area found as basic in reaction, salt free, low organic matter & total N contents, medium water holding capacity and medium textured (Table 1). The data collected for both year fields were combinely analyzed following the procedure as described by Steel & Torrie (1986). MSTAT-C computer software package have used for calculating the analysis of variance (ANOVA) and least significance difference test (LSD) to separate their mean values. Simple correlation coefficients (r) studies have also worked out for aforementioned entries following the procedure reported by Fisher & Yates (1953). Growth attributes of mungbean cultivars also correlated with their respective grain yield, which has already been explained and discussed in detail by Achakzai & Habibullah (2012).

Table 1. Physicochemical characteristics of soil used for the study of field-grown mungbean (*Vigna radiata* L.).

Soil depth (cm)	TSS (ppm)	pH	ECe (mS cm^{-1})	Organic matter (%)	Water holding capacity (%)	Total N (%)	Sand (%)	Silt (%)	Clay (%)	Textural class
0-15	1945	7.13	3.05	2.309	37.85	0.1150.096 0.065	22.84	49.61	27.95	Clay loam
16-30	1957	7.75	3.11	1.927	37.95		22.80	49.36	27.88	
31-45	1998	8.74	3.25	1.317	37.88		22.65	49.81	27.57	
Mean	1966	7.87	3.14	1.851	37.89	0.092	22.76	49.59	27.80	
CFC	-	***Basic**	***Salt free**	***Low**	**Medium**	**Low**	-	-	-	****Medium textured**

CFC = Categories for classification; *and** following the soil classification of Kayani and Sheikh (1981) and Anon., (1953), respectively

Results and Discussion

Data presented in Table 2 showed that in response to various levels of added N fertilizer, all mentioned growth attributes (except days to maturity and leaf area) of mungbean were found to be slightly ($p<0.05$) to highly ($p<0.01$) significant. Similar response is also recorded for various cultivars (Table 2). However, interaction between fertilizer treatments and cultivars were mostly found non-significant (except days to 50% flowering).

Table 2. Analysis of variance (ANOVA) for yield and yield attributes of mungbean (*Vigna radiata* L.) cultivars in response to different levels of applied nitrogen fertilizer.

S. No.	Variables	Sum of squares		Mean squares		F-Value of variables		
		Fertilizer (F)	Variety (V)	Fertilizer (F)	Variety (V)	Fertilizer (F) (Df=5)	Variety (V) (Df=3)	F x V (Df=15)
1.	Days to 50% flowering	292.813	169.410	58.563	56.470	9.9399**	5.5117**	1.8819*
2.	Days to maturity	61.229	16.188	12.246	5.396	1.2143 ^{NS}	0.5348 ^{NS}	0.5386 ^{NS}
3.	Numbers of leaves plant^{-1}	12.118	16.188	2.424	5.396	3.4486**	6.4038**	1.5973 ^{NS}
4.	Plant height (cm)	780.876	1876.630	156.175	625.543	3.8167**	37.5272**	1.4708 ^{NS}
5.	Number of branches plant^{-1}	6.2222	6.4722	1.24444	2.15741	3.95*	4.74**	0.53 ^{NS}
6.	Leaf area (cm^2)	1115.441	178.578	223.088	59.526	2.2645 ^{NS}	2.2209 ^{NS}	1.0184 ^{NS}

* and ** are slightly and highly significant at $p<0.05$ and $p<0.01$, respectively. While ns stands for non-significant at both probability levels

Days to 50% flowering: Results revealed that there was a significant difference among different doses of added N fertilizer (Table 3). The plants of T5 treatment took minimum days to flowering (43.75), followed by T2 (44.33). The maximum day to flowering (48.25) was recorded for highest dose of N fertilizer (100 kg ha^{-1}). Results further showed that cultivars are also varied significantly in relation to receiving various levels of applied N doses. The cultivar NCM-209 took maximum days to flowering, but was statistically at par with NM-92. While the minimum days to flowering were taken by M-1 and was statistically at par with NM-98. The variation in days to flowering might have been genetically controlled character. Similar results have also been recorded by Aslam *et al*., (2004); Khattak *et al., (*2006) and Law-Ogbomo & Egharevba (2009). Results also showed that there was a significant interaction between fertilizer doses and cultivars. Statistically maximum days to 50% flowering took for T6V1 & T1V4, while minimum for T5V1 & T1V4. The correlation coefficient (r) studies exhibited that days to flowering are highly significantly but negatively associated with plant height (r=-0.338), leaf area (r=-0.287) and yield ha^{-1} (r=-0.265). Therefore, this growth attribute could be exploited in breeding programme (Table 4). However, these findings are not in line with those described by Reddy *et al.,* (1991) and Siddique *et al.,* (2006).

Days to maturity: Results displayed in Table 3 revealed that there was a non-significant variation among various doses of added N fertilizer. The plants grown in the plots of T2 treatment numerically took minimum days to maturity (83.83), followed by T5 (85.00) and T3 (85.04). While maximum days to maturity (86.04) noted for highest dose of applied N fertilizer (100 kg ha^{-1}). Results further narrated that different cultivars exhibited non-significant response to supplied N fertilizer (Table 3). Aslam *et al.,* (2004) also recorded similar findings, but Khan *et al.,* (2008) stated that crop maturity delayed by application of N fertilizer. Whereas other researchers revealed that maturity of a crop depends upon photoperiod of genotypes/cultivars, temperatures and slightly on available moisture contents of the plants. Researchers also explained that days to maturity is a varietal dependant attribute, which influenced by genetic make up of a cultivar and its environment. However, in present study reverse is true for the case. This might be due to cultivars relation to same maturity group. Therefore, present findings in term of days to maturity are not in accordance with those explained by Reddy *et al.,* (1991), Siddique *et al.,* (2006) and Rahim *et al.,* (2008). Results also revealed that there was a non-significant interaction among fertilizer and mungbean cultivars. Numerically maximum days to maturity took by T6V2 (87.17) while minimum for T2V2 (82.67). The correlation coefficient (r) studies recorded in Table 4 depicted that days to maturity by mungbean cultivars are slightly but negatively associated only with number of leaves plant^{-1} (r=-0.194). While non-significant correlations exhibited for remaining attributes (including yield). These findings in general are in contradiction with those recorded by other researchers (Siddique *et al.,* 2006; Zubair *et al.,* 2007).

Number of leaves plant^{-1}: Results showed that there was a significant but inconsistant difference occurred among different doses of applied N fertilizer. The maximum number of leaves plant^{-1} (5.708) recorded in control treatment (T1) followed by T3, while the minimum (4.857) noted for T4 dose of fertilizer (Table 3). Results also showed that cultivars responded significantly in relation to receiving various doses of added N fertilizer. The maximum number of leaves plant^{-1} (5.861) noted for NCM-209, but it was statistically at par with NM-98, M-1 and NM-92, respectively. Results further enumerated that there was a non-significant interaction between applied doses of fertilizer and mungbean cultivars. Numerically maximum number of leaves plant^{-1} noted for T1V4 (6.57) & T3V2 (6.50), while minimum for T3V1 (4.50) & T6V1 (4.50). Although no any extensive research, work carried out on the response of total number of leaves toward added N fertilizer. However, Bhuiyan *et al.,* (2008) studied that inoculated plants produced significantly higher number of leaves with P and Mo. Highest number of leaves (22.84) was found with P and Mo level for 40 and 1.0 kg ha^{-1}, respectively which was statistically significant with control (19.27). The correlation coefficient (r) studies recorded in Table 4 exhibited that number of leaves plant^{-1} was highly significantly and positively associated with plant height (r=0.482), leaf area (r=0.347) and grain yield (r=0.325), but negatively associated with days to maturity (-0.194).

Table 3. Response of four mungbean [*Vigna radiata* (L.) Wilczek] cultivars to different levels of nitrogen fertilizer.

Levels (kg ha^{-1})	Days to flowering	Days to maturity	Number of leaves plant^{-1}	Plant height (cm)	Number of branches plant^{-1}	Leaf area (cm^2)
A. Applied NPK						
T1 = 0+0+0	46.50 $^{a-c}$	85.33	5.708 ^{a}	29.64 ^{c}	3.17 ^{c}	24.36
T2 = 20+50+30	44.33 ^{cd}	83.83	5.500 ^{ab}	36.81 ^{a}	3.50 ^{abc}	30.97
T3 = 40+50+30	46.92 ^{a}	85.04	5.583 ^{ab}	35.95 ^{ab}	3.38 ^{bc}	27.46
T4 = 50+50+30	45.25 $^{b-d}$	85.13	4.875 ^{c}	33.89 ^{ab}	3.58 ^{ab}	28.13
T5 = 80+50+30	43.75 ^{d}	85.00	5.292 $^{a-c}$	34.82 ^{ab}	3.63 ^{ab}	33.19
T6 = 100+50+30	48.25 ^{a}	86.04	5.083^{bc}	32.92 ^{bc}	3.83 ^{a}	29.65
B. Cultivars						
V1 = NM-92	45.78 ^{ab}	84.81	4.944 ^{b}	28.63 ^{d}	3.17 ^{b}	29.43
V2 = NM-98	44.72 ^{b}	85.31	5.361 ^{b}	35.55 ^{b}	3.53 ^{a}	29.83
V3 = M-1	45.11 ^{b}	85.47	5.194 ^{b}	38.52 ^{a}	3.72 ^{a}	29.53
V4 = NCM-209	47.72 ^{a}	84.67	5.861 ^{a}	33.31 ^{c}	3.64 ^{a}	27.05
C. Interaction (A X B)						
T1 x V1	42.67 ^{de}	85.50	5.833	25.63	3.00	27.88
T2 x V1	45.66^{a-e}	84.33	4.833	27.90	3.00	28.50
T3 x V1	49.00 $^{a-c}$	85.17	4.500	30.30	2.67	26.88
T4 x V1	44.67 $^{b-e}$	85.00	4.667	30.50	3.17	31.71
T5 x V1	42.33 ^{e}	83.83	5.333	29.80	3.33	32.97
T6 x V1	50.33 ^{a}	85.00	4.500	27.67	3.83	28.67
T1 x V2	45.33 $^{a-e}$	86.33	5.000	29.43	3.17	24.33
T2 x V2	43.33 ^{de}	82.67	5.333	37.03	3.50	31.17
T3 x V2	44.00 $^{b-e}$	84.33	6.500	37.20	3.50	30.76
T4 x V2	43.67 $^{c-e}$	85.17	4.667	36.50	3.67	29.70
T5 x V2	44.00 $^{b-e}$	86.17	5.333	38.93	3.67	32.07
T6 x V2	48.00 $^{a-d}$	87.17	5.333	34.20	3.67	30.94
T1 x V3	47.67 $^{a-e}$	85.67	5.333	34.60	3.17	22.90
T2 x V3	44.33 $^{b-e}$	83.33	5.833	42.53	3.67	33.74
T3 x V3	45.33 $^{a-e}$	85.50	5.167	42.10	3.67	27.19
T4 x V3	45.67 $^{a-e}$	85.50	4.833	36.00	3.83	26.65
T5 x V3	42.33 ^{e}	86.17	5.167	37.77	3.83	36.05
T6 x V3	45.33 $^{a-e}$	86.67	4.833	38.13	4.17	30.64
T1 x V4	50.33 ^{a}	83.83	6.667	28.90	3.33	22.35
T2 x V4	44.00 $^{b-e}$	85.00	6.000	39.77	3.83	30.45
T3 x V4	49.33 ^{ab}	85.17	6.167	34.20	3.67	25.00
T4 x V4	47.00 $^{a-e}$	84.83	5.333	32.57	3.67	24.46
T5 x V4	46.33 $^{a-e}$	83.83	5.333	32.77	3.67	31.66
T6 x V4	49.33 ^{ab}	85.33	5.667	31.67	3.67	28.36
LSD for A (5%)	2.311	1.493	0.4314	1.198	0.3612	2.433
LSD for B (5%)	2.445	1.912	0.5049	3.852	0.3152	5.977
LSD for C (5%)	3.684	3.656	1.0570	4.699	0.7592	5.959
CV (%) Grand	6.86%	3.73%	17.19 %	12.01%	15.98	17.88%
Mean	46.688	85.063	5.340	34.004	3.5139	28.960

Means followed by same letter(s) within the same column for each factor are not significantly different at 5% probability level

Table 4. Correlation coefficient (r) studies of various growth attributes and yield of field-grown mungbean [*Vigna radiata* (L.) Wilczek] cultivars

Variables number	1	2	3	4	5	6	7
1	1.000						
2	0.083^{NS}	1.000					
3	-0.338^{**}	-0.084^{NS}	1.000				
4	-0.137^{NS}	-0.194^{*}	0.482^{**}	1.000			
5	-0.062^{NS}	-0.064^{NS}	0.175^{*}	-0.148^{NS}	1.000		
6	-0.287^{**}	-0.103^{NS}	0.502^{**}	0.347^{**}	0.026^{NS}	1.000	
7	-0.265^{**}	-0.056^{NS}	0.593^{**}	0.325^{**}	0.187^{*}	0.342^{**}	1.000

*and** significant at p<0.05 and p<0.01 respectively, and NS stands for non-significant. Variables # (1) days to 50% flowering, (2) days to maturity, (3) plant height, (4) number of leaves plant^{-1}, (5) number of brances plant^{-1}, (6) leaf area and (7) yield kg ha^{-1}

Plant height (cm): Results pertaining to plant height showed that there was a significant difference among different doses of N fertilizer. The plants of T2 gained maximum height (36.81 cm) followed by T3 (35.95 cm) and T5 (34.82 cm). Whereas the short stature plants (29.64 cm) obtained in plots either receiving no fertilizer, or receiving maximum dose of fertilizer i.e., 100+50+30 kg NPK ha^{-1}. Results also showed that cultivars behaved differentially in attaining the height of plants. The mungbean cultivar M-1 produced the tallest plants (38.52 cm), whereas NM-92 produced the shortest plants (28.63 cm). However, the cultivar NM-98 and NCM-209 produced the intermediate stature plants, respectively. Plant height, being a genetically controlled character, varied in response to various doses of added fertilizer and cultivars also recorded by many other researchers (Ashraf *et al.,* 2003; Sirohi & Kumar, 2006; Rahim *et al.,* 2008; Law-Ogbomo and Egharevb, 2009; Bozorgi *et al.,* 2011). Results further showed that there was a non-significant interaction between fertilizer and cultivars. Numerically the tallest plants (42.53 cm) recorded for T2V3 followed by T3V3 (42.10 cm). Whereas, minimum statured plants (25.63 cm) obtained for T1V1 (Table 3). The correlation coefficient (r) studies revealed that plant height exhibited highly significant positive association with number of leaves plant^{-1} (r=0.482), leaf area (r=0.502), number of branches plant^{-1} (r=0.175), and grain yield (r=0.593). Therefore, such direct effect of plant stature on yield indicating that this trait should gave more emphasis while selecting high yielding mungbean cultivars especially for rainfed conditions (Table 4). Zubair *et al.,* (2007) also expressed significant positive correlation between plant height and yield. However, in present study plant height also exhibited significant but negative association with days to 50% flowering (r=-0.338), which are not in line with the results obtained by Rohman *et al.,* (2003).

Number of branches plant^{-1}: Results regarding number of branches plant^{-1} exhibited that there was a significant difference among various treatments of N fertilizer when compared it with their control treatment (T1). The plants of T6 produced the maximum number of branches plant^{-1} (3.83), whereas minimum recorded for T1 (3.17). Results also exhibited that cultivars behaved differentially in term of producing branches plant^{-1}. The mungbean cultivar NM-92 produced the least number of branches plant^{-1}, while the remaining 3 cultivars did not responded significantly (Table 3). The variation in number of branches plant^{-1} among cultivars is mostly due to the differences in their genetic makeup. Similar results are also explained by Anonymous (2007) and Begum *et al.,* (2009). The highest number of branches by them was recorded in mungbean variety BINA moog7 (3.50), and BINA moog6 produced the lowest one (0.50). Whereas, Ayub *et al.,* (2010) stated that application of nitrogen significantly increased the forage yield of cluster bean varieties, and maximum yield of 63.70 kg ha^{-1} recorded at 50 kg N ha^{-1}. According to them, such an increase in yield was mainly attributed to greater number of branches, leaves, leaf area plant^{-1}, and plant height. Results further enumerated that there was a non-significant interaction between fertilizer treatments and cultivars. Numerically maximum number of branches plant^{-1} (3.83) noted for T2V4; T4V3; T5V3 and T6V1, while minimum (2.67) recorded for T3V1. The correlation coefficient (r) studies revealed that number of branches plant^{-1} was highly-significantly and positively correlated with plant height (r=0.502), number of leaves plant^{-1} (r=0.347) and yield ha^{-1} (r=0.342). However, it also significantly but negatively associated (r=-0.287) with days to 50% flowering (Table 4).

Leaf area (cm^2): Results obtained for leaf area deciphered that there was a non-significant difference between various treatments of applied N fertilizer (Table 3). The plants grown in T5 treatment numerically attained maximum leaf area (33.19 cm^2) followed by T2 (30.97 cm^2). Whereas, the minimum leaf area (24.36 cm^2) recorded for treatment receining no added fertilizer (T1). Although no any extensive work has been done about fertilizer effects on leaf area. However, the results of Polthanee and Kotchasatit (1999) showed that leaf area indices (LAI) of mungbean significantly affected by intercropping pattern. However, Ayub *et al.,* (2010) explained that application of nitrogen fertilizer significantly increased the forage yield of cluster bean varieties, and maximum yield of 63.70 kg ha^{-1} recorded at 50 kg N ha^{-1}. According to them, this increase in yield was mainly due to greater leaf area $plant^{-1}$, number of branches $plant^{-1}$, leaf area $plant^{-1}$, and plant height. Likewise, cultivars also behaved non-differentially in term of leaf area. These findings are not in line with Nemat *et al.,* (2000). They stated that Giza-1 was superior to Kawmy-1 in terms of leaf area ratio (LAR) and fertilizer application significantly influenced the LAI at all growth stages. Results also revealed that there was a non-significant interaction among fertilizer and mungbean cultivars. Numerically maximum leaf area is obtained for T5V3 (36.05 cm^2) while minimum for T1V4 (22.35 cm^2). The correlation coefficient (r) studies (Table 4) exibited that leaf area of mungbean cultivars are highly significantly and positively associated only with plant height (r=0.502), number of leaves $plant^{-1}$ (r=0.347), and yield kg ha^{-1} (r=0.342). While highly significant but negative correlations are also exhibited with days to 50% flowering (r=-0.287). Hossain (2006) also reported that leaf area significantly and positively correlated with plant height.

Conclusions

It can be concluded that different fertilizer levels did significantly ($p<0.05$) influenced most of the growth attributes of the mungbean. Maximum days to flowering (48.25) and number of branches $plant^{-1}$ (3.83) recorded for plants subjected to highest dose of applied N fertilizer viz., 100 kg ha^{-1}. Similar response toward added N fertilizer also recorded for different cultivars of mungbean. Maximum days to 50% flowering (47.72) and number of leaves $plant^{-1}$ (5.86) is noted for NCM-209. Whereas, the maximum plant height (38.52 cm) number of branches $plant^{-1}$ (3.72) obtained for mungbean cultivar M-1. The correlation coefficient (r) studies exibited that plant height (r=0.593), number of leaves $plant^{-1}$ (r=0.325), number of braches $plant^{-1}$ (r=0.187) and leaf area (r=0.342) significantly ($p<0.05$) and positively correlated with their grain yield (kg ha^{-1}). However, days to 50% flowering (r=-0.265) are also significantly but negatively associated with their grain yield (kg ha^{-1}). Thus based on correlation studies it can be cocluded that cultivars under cultivation displayed a wide range of variation for most of the mentioned growth traits and could exploit in breeding programme to enrich the mungbean genetic treasure.

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