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EFFECT OF VARIOUS LEVELS OF NITROGEN FERTILIZER ON SOME VEGETATIVE GROWTH ATTRIBUTES OF PEA (*PISUM SATIVUM* L.) CULTIVARS

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Abstract

A field experiment was conducted for 2 consecutive growing years on few growth characteristics of four pea cultivars *viz.,* Arkel, Climax, Green Feast and Olympia in response to different levels of N fertilizer under the climatic conditions of district Mastung, Balochistan. Six N fertilizer levels (0, 25, 50, 75, 100 and 125 kg N ha^{-1}) plus a constant dose of 60+40 kg P_2O_5 & K_2O ha^{-1} were prepared, and designated as T_1 to T_7, respectively. These N levels were applied to each sub-plot (except T_1 & T_2) in two split doses first at the time of flowering and second at the time of pod formation to quantify how much N fertilizer's required by different pea cultivars to realize the highest growth and yield. Results exhibited that in response to various levels of added N fertilizer, all mentioned growth attributes were found to be highly significant ($P<0.01$). However, cultivars response was found significant only for secondary branches $plant^{-1}$, plant height and shoot moisture contents. A maximum number of primary branches $plant^{-1}$ (6.94), secondary branches $plant^{-1}$ (10.72), plant height (69.77 cm), number of leaves $plant^{-1}$ (19.75), leaf length (11.81 cm) and shoot moisture contents (571.0 g kg^{-1}) was recorded with application of 100 kg N ha^{-1}. The interaction between fertilizer and pea cultivars was found non-significant for all mentioned attributes in the trial. Results further revealed that all growth parameters were slightly to highly significant and positively correlated among themselves as well as with their fresh pod yields. These attributes could be used a suitable selection criteria for predicting the fresh pod yield and also for breeding purposes in peas.

Introduction

Pea (*Pisum sativum* L.) is an important nutritive vegetable and is mainly cultivated as cool (rabi) season crop throughout the globe, but is also cultivated in summer in hilly areas. It is considered as an important cultivated legume next to soybean, groundnut and beans (Hules, 1994). Grain legumes, especially peas, could play a key role in organic cropping systems (Aslam *et al*., 2010). They could provide nitrogen (N) to the system via N_2 fixation and produce grain rich in protein while improving soil N for the succeeding crop (Corre-Hellou & Crozat, 2005). Economically pea is predominant export and cash crop in world trade and represents about 40% of the total trading in pulses (Oram & Agcaoili, 1994). The pea crop also occupies the third position among the major grain legume in Pakistan (Aslam *et al.,* 2000; Kazmi *et al.,* 2002).

Legumes (including peas) are grown on about 2.0% (2.09 million hectares) of total cultivated land of Pakistan. Almost all of this is in two provinces (Khyber Pakhtoon Khwa and Punjab) and is mainly concentrated in Malakand and Potohar divisions (Aslam *et al.,* 2000). While in province of Balochistan, peas are grown in an area of 784 hectares, with total production of 8611 tons (Anon., 2002-2003). In Pakistan the cultivation and production of peas are very low as compared with most of the countries of the world. Some time country has to spend lot of foreign exchange to import pulses to meet the national food requirements (Aslam *et al.,* 2000). There are so many constrains which limits the crop production by reducing their growth and yield in the country. Out of which misuse of fertilizer and unavailability of improved varieties of seeds are the main limiting factors, which limits the crop growth. Although varieties of a crop may exist elsewhere, but differences in climate, soil, flowering and other agronomic factors may also affect their growth potential locally. Therefore, varieties may have to be tested for special local growing conditions (Hussain *et al.,* 2002). The soil of the study area is deficient in available nitrogen, need sufficient amount of additional nitrogen fertilizer for non-leguminous and small amount as starter dose for leguminous crops (Anon., 1995).

Research revealed that application of nitrogen fertilizer significantly and positively influenced the plant height, number of primary and secondary branches $plant^{-1}$ of many legume crops (Subhan, 1991; Jefing *et al.,* 1992; Ladha *et al.,* 1993; Achakzai *et al.,* 2002a,b; Toğay *et al.,* 2005), but very little is known about the influence of nitrogen on the growth of pea under field conditions. Prasad *et al.,* (1989) observed the effect of varying doses of P with constant doses of N and K @20+25 kg ha^{-1}, respectively. They noted increased plant growth with increasing the rate of 0-120 kg P ha^{-1}. Kostov *et al.,* (1989) observed the effects of limited dose of P and N fertilizers on the growth of winter pea cv. 11. However, maximum plant height and number of branches $plant^{-1}$ of local pea variety were recorded in applied fertilizer dose @75-120-120 or 75-120-00, kg NPK ha^{-1} (Kakar *et al.,* 2002).

The yield of plant is a dependent variable, which depends upon all other growth and yield contributing traits. Therefore, it is generally correlated with all other components. Many researchers reported significant positive correlation of number of branches $plant^{-1}$ and plant height of many legumes with their respective grain yield (Khan *et al*., 1983; Khan *et al*., 2002a,b; Achakzai *et al.,* 2002a,b; Achakzai & Kayani, 2004). Significantly positive relationships were found among seed yield, plant height and number of branches $plant^{-1}$ in pea cultivars (Vahdettin *et al.,* 2004) and cowpea genotypes (Peksen, 2004). A highly significant positive correlation coefficient of primary and secondary branches with the grain yield of 219 chickpea genotypes was also established by Qureshi *et al.,* (2004).

The present study was therefore, mainly envisaged to evaluate the beneficial effect of varying levels of nitrogen fertilizer on various growth components of four cultivars

of peas under the existing climatic conditions of district Mastung. The study was also furnished to quantify how much N fertilizer is required by different pea cultivars to realize the highest growth and fresh grain yield. The study was also aimed to establish relationship between different growth traits and with their fresh pod yields.

Materials and Methods

The present field experiment was conducted at district Mastung (situated 30 km south of provincial capital, Quetta). The experiment was initiated during winter (rabi) season for 2 consecutive years i.e., 1999-2000 & 2000-2001. The experimental plots were laid out in a Randomized Complete Block Design (RCBD). Four varieties of pea *viz.,* Arkel, Climax, Green Feast and Olympia were grown in the experimental plot. The sub-plots were prepared and experiment was arranged in three replicates having plot size of 5 x 15m^2. Before sowing, a constant dose of phosphorus (P_2O_5) in the form of triple super phosphate (TSP) and potassium (K_2O) in the form of sulphate of potash (SOP) @ 60 + 40 kg ha^{-1} were applied to each sub-plot (except control). The pre-soaked seeds were sown in rows by hand, keeping space of 50 and 25cm inter and intra, respectively. Six N fertilizer doses @ 0, 25, 50, 75, 100 and 125 kg ha^{-1} in the form of urea were applied to each sub-plot in two split doses except of 60+40 kg P_2O_5 & K_2O ha^{-1} which was applied as a single dose. These fertilizer treatments were the designated as T_1 to T_7, respectively. The 1st dose of N was applied at the time of flowering initiation and the 2nd one at the time of pod formation. When crop nearly reached to their physiological maturity, then five plants were randomly selected from each sub-plot for the number of primary branches & secondary branches plant^{-1}, plant height, number of leaves plant^{-1}, leaf length, and shoots moisture contents. Achakzai & Bangulzai (2006) has also given detail about the present study.

Data obtained were statistically analyzed, following the procedure described by Steel & Torrie (1980). MSTAT-C computer software package was used and correlation coefficient (r) studies were also made following the procedure described by Fisher & Yates (1953).

Results and Discussion

Number of branches plant^{-1}: Data pertaining to primary and secondary branches plant^{-1} deciphered that N fertilizer doses significantly increased their number (Tables 1 & 2). A maximum number of primary (6.94) and secondary branches (10.72) were recorded with an application of 100 kg N ha^{-1} (T_6) while in case of cultivars, secondary branches plant^{-1} was noted to be maximum in Green Feast (8.87) and Climax (8.43). These findings are also in line with Kakar *et al.,* (2002), Yemane & Skjelvag, (2003) and EL-Desuki *et al.,* (2010), as the present figures are at par with that recorded by them for the same climax cultivar (5.60). Various other workers have already reported similar results from their studies on mungbean (Alam *et al.,* 2010), and other legume crops viz., chickpea (Qureshi *et al.,* 2004), lentils (Toğay *et al.,* 2005) and soybean (Subhan, 1991; Achakzai *et al.,* 2002a). Results also indicate that interaction between fertilizer and cultivars are non-significant, which is also in accordance with the results obtained by Ali *et al.,* (2003).

Table 1. Effect of various levels of nitrogen on the number of primary branches plant^{-1} of pea cvs.

N Levels (kg ha^{-1})		Arkel	Climax	Green Feast	Olympia	Means
T_1	0:0:0	4.90	4.84	6.34	6.10	5.54 c
T_2	0:60:40	5.74	5.80	6.80	5.47	5.95 bc
T_3	25:60:40	5.77	5.87	5.60	5.10	5.58 c
T_4	50:60:40	5.47	6.27	5.74	6.07	5.88 bc
T_5	75:60:40	6.54	6.54	7.20	6.50	6.69 a
T_6	100:60:40	6.70	7.27	6.44	7.37	6.94 a
T_7	120:60:40	6.24	6.90	6.70	6.30	6.53 ab
Means		5.90	6.21	6.40	6.13	6.16

Means followed by the same letters are statistically not significantly different at 5% LSD. Coefficient of variance = 13.47%
LSD at 5% for cvs = 1.04
LSD 5% for N levels = 0.68

Table 2. Effect of various levels of nitrogen on the number of secondary branches plant^{-1} of pea cvs.

N Levels(kg ha^{-1})		Arkel	Climax	Green Feast	Olympia	Means
T_1	0:0:0	5.90	6.87	6.70	6.54	6.50 e
T_2	0:60:40	6.37	7.07	7.87	7.04	7.08 de
T_3	25:60:40	7.77	7.20	7.77	7.74	7.62 cd
T_4	50:60:40	7.60	8.17	8.74	8.27	8.19 c
T_5	75:60:40	9.27	9.24	9.34	8.87	9.18 b
T_6	100:60:40	10.67	10.90	11.64	9.70	10.72 a
T_7	120:60:40	8.20	9.60	10.07	8.44	9.07 b
Means		7.97 b	8.43 ab	8.87 a	8.08 b	8.33

Means followed by the same letters are statistically not significantly different at 5% LSD. Coefficient of variance = 8.99%
LSD at 5% for cvs = 0.58
LSD 5% for N levels = 0.62

Plant height (cm): Plant height was significantly and positively influenced both by cultivars and applied N levels (Table 3). The maximum plant height (69.77 cm) was recorded with an application of 100 kg N ha^{-1}(T_6). Whereas in case of cultivars, the maximum plant height was recorded in cvs. Climax (57.79 cm) and Green Feast (56.80 cm), but remaining two cultivars responded equally. Same results both for N levels and varieties are also recorded by Kakar *et al.,* (2002), but present figure is at par than their recorded ones for the same climax cultivar (46.30 cm). Many other researchers also reported similar results in mungbean (Alam *et al.,* 2010), and also for various other legumes i.e., chickpea (Qureshi *et al.,* 2004), lentils (Toğay *et al*., 2005) and soybean (Achakzai *et al.,* 2002a,b; Achakzai & Kayani, 2004). Results also indicate that interaction between fertilizer and cultivars are non-significant, which is also in line with the results of by Ali *et al.,* (2003).

Table 3. Effect of various levels of nitrogen on plant height (cm) of pea cvs.

N Levels (kg ha^{-1})		Arkel	Climax	Green Feast	Olympia	Means
T_1	0:0:0	45.14	46.66	47.16	45.44	46.10 f
T_2	0:60:40	46.17	47.83	48.62	46.84	47.36 f
T_3	25:60:40	47.34	50.04	50.83	47.26	48.86 e
T_4	50:60:40	49.65	53.39	54.19	49.64	51.71 d
T_5	75:60:40	65.02	66.58	61.32	57.67	62.64 c
T_6	100:60:40	72.15	73.04	69.45	64.46	69.77 a
T_7	120:60:40	65.60	66.99	66.09	64.19	65.71 b
Means		55.8 b	57.79 a	56.80 ab	53.65 c	56.02

Means followed by the same letters are statistically not significantly different at 5% LSD. Coefficient of variance = 2.96%.
LSD at 5% for cvs = 1.56
LSD 5% for N levels = 1.36

Number of leaves and leaf length: Data presented in Tables 4 & 5 exhibited significant positive response in relation to receiving various doses of applied N fertilizer, whereas, variation among cultivars are found to be non-significant. The maximum number of leaves $plant^{-1}$ (19.75) and average leaf length (11.81 cm) were recorded with an application of 100 kg N ha^{-1}(T_6). Similar findings have been achieved by EL-Desuki *et al.,* (2010). They recorded significant and linear increase by increasing the applied compost and bi-fertilizer. Akhtar *et al.,* (1988), Singh & Singh (1995) and Achakzai *et al.,* (2002a) also obtained similar results for soybean crop.

Table 4. Effect of various levels of nitrogen on the number of leaves $plant^{-1}$ of pea cvs.

N Levels (kg ha^{-1})		Arkel	Climax	Green Feast	Olympia	Means
T_1	0:0:0	15.90	16.20	16.07	16.00	16.04 d
T_2	0:60:40	17.17	16.10	16.60	16.50	16.59 cd
T_3	25:60:40	17.17	17.10	17.07	17.23	17.14 c
T_4	50:60:40	17.84	17.90	18.34	17.74	17.95 b
T_5	75:60:40	18.84	19.54	20.50	18.97	19.46 a
T_6	100:60:40	20.27	19.20	20.00	19.54	19.75 a
T_7	120:60:40	18.57	18.50	18.34	18.04	18.36 b
Means		17.96	17.79	18.13	17.71	17.89

Means followed by the same letters are statistically not significantly different at 5% LSD. Coefficient of variance = 5.25%
LSD at 5% for cvs = 0.77
LSD 5% for N levels = 0.77

Table 5. Effect of various levels of nitrogen on leaf length (cm) of pea cvs.

N Levels (kg ha^{-1})		Arkel	Climax	Green Feast	Olympia	Means
T_1	0:0:0	9.14	9.50	9.40	9.37	9.35 d
T_2	0:60:40	9.30	9.14	9.90	9.40	9.43 d
T_3	25:60:40	9.64	9.57	9.70	10.24	9.78 d
T_4	50:60:40	9.80	10.24	10.74	10.44	10.30 c
T_5	75:60:40	10.20	10.97	10.97	11.00	10.78 cd
T_6	100:60:40	11.60	11.97	11.97	11.70	11.81 a
T_7	120:60:40	10.67	11.00	11.16	11.34	11.04 b
Means		10.05	10.34	10.54	10.49	10.35

Means followed by the same letters are statistically not significantly different at 5% LSD. Coefficient of variance = 5.92%
LSD at 5% for cvs = 0.50
LSD 5% for N levels = 0.50

Shoot moisture contents: The maximum moisture content (571.0 g kg^{-1}) was noted with an application of 100 kg N ha^{-1} (T_6), beyond this reduction was noticed (Table 6). On the other hand, cultivars response were also found significant by producing greatest values for cultivar Green Feast (537.7 g kg^{-1}) followed by Climax (513.3 g kg^{-1}). No any such work has been carried out on peas. However, similar trend of results has been received by Hussain *et al.,* (1992) and Achakzai *et al.,* (2002a) on soybean.

Table 6. Effect of various levels of nitrogen on shoot moisture contents (g kg^{-1}) of pea cvs.

N Levels (kg ha^{-1})		Arkel	Climax	Green feast	Olympia	Means
T_1	0:0:0	444.2	446.0	485.0	441.2	454.2 e
T_2	0:60:40	440.4	453.1	495.7	454.3	460.8 e
T_3	25:60:40	482.7	488.7	515.3	474.2	490.2 d
T_4	50:60:40	496.5	520.7	557.4	509.8	518.6 c
T_5	75:60:40	524.8	557.5	575.0	531.0	547.2 b
T_6	100:60:40	565.8	575.8	586.8	555.6	571.0 a
T_7	120:60:40	521.0	551.8	558.4	528.3	539.9 b
Means		496.5 c	513.3 b	537.7 a	499.2 c	511.7

Means followed by the same letters are statistically not significantly different at 5% LSD. Coefficient of variance = 2.12%
LSD at 5% for cvs = 0.87
LSD 5% for N levels = 0.89

Correlation: The correlation coefficient data presented in Table 7 showed that all mentioned growth characteristics in general were highly significantly (P<0.01) and positively correlated with each other and with their fresh pod yield, which has been already explained by Achakzai & Bangulzai (2006). The same positive and significant relationships were also found among seed yield, number of branches plant^{-1} and plant height in peas (Vahdettin *et al.,* 2004). However, significant positive association for number of leaves plant^{-1} & leaf length (cm) and shoot moisture contents (g kg^{-1}) are reported for the first time in the present studies. Many other workers have already reported similar results from their studies on various legumes viz., chickpea (Sarviliya & Goyal, 1994; Tripathi, 1998; Qureshi *et al.,* 2004), cowpea (Peksen, 2004), mashbean (Mahmood-ul-Hassan *et al.,* 2003), peanut genotypes (Khan *et al.,* 2002b) and soybeans (Achakzai *et al.,* 2002a,b; Khan *et al.,* 2002a; Achakzai & Kayani, 2004). Therefore, from these findings it could be proposed that cultivars with high values of growth parameters that had positive correlation with fresh pod yield can be utilized in hybridization for the development of new pea cultivar with a combination of these traits. Because, these components play an important role in the partitioning of pod and grain yields. Hence attributes like this may be put together in a single genotype for yield improvement.

Table 7. Correlation coefficient (r) studies of various growth components of peas (*Pisum sativum* L.) with their respective fresh pod yields.

Growth components	1	2	3	4	5	6	7
1) Primary branches plant^{-1}.	1.000						
2) Secondary branches plant^{-1}.	0.428**	1.000					
3) Plant height (cm).	0.494**	0.806**	1.000				
4) Number of leaves plant^{-1}.	0.521**	0.704**	0.751**	1.000			
5) Leaf length (cm).	0.420**	0.710**	0.788**	0.705**	1.000		
6) Shoot moisture contents (g, kg^{-1}).	0.496**	0.834**	0.864**	0.789**	0.778hs	1.000	
7) Fresh pod yields (kg ha^{-1}).	0.226*	0.344**	0.362**	0.359**	0.267*	0.379**	1.000

* and ** are standing for slightly and highly significant at P<0.05 and P<0.01 level of significance, respectively.

Conclusions

On the basis of obtained results, it can be concluded that all mentioned growth attributes of pea in relation to different levels of applied N fertilizer are statistically found to be highly significant (p<0.01). Generally similar response is also obtained for their cultivars. A maximum growth response is recorded for applied N fertilizer dose of 100 kg ha^{-1} (T_6). Likewise among 4 cultivars, the cv Green Feast was found to be promising in their growth response followed by cv. Climax whereas, cvs. Olympia and Arkel did not behave differentially. Therefore, on the basis of outstanding growth performance, the cultivar Green Feast is recommended for the pea growers of Mastung region. The correlation coefficient (r) studies also concluded that most of the mentioned attributes are highly significantly and positively correlated among themselves as well as with their fresh pod yields. Therefore, the aforementioned growth parameters could be used in hybridization for the development of new pea cultivar and this may be put together in a single genotype for their fresh and dry yield improvements.

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