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Effect of Split Application of Nitrogen Levels on the Quality and Quality Parameters of Pea (*Pisum sativum* L.)

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ABSTRACT

A field experiment was carried out to evaluate the effect of split application of different levels of nitrogen fertilizer on the quality and quantity contributing parameters of pea crop. Nitrogen @ 40 and 80 kg ha^{-1} was applied in two and four split doses in different proportions. Nitrogen levels did not show significant performance in germination % age, days to first flower appearance, leaf size, number of pods per plant, number of seeds per pod, grain weight (100 seed) and moisture %. Whereas, the plant height (g), weight of pods (g), yield per plot (g), protein content % age and ash content % age, of peas were significantly affected by the application of different nitrogen levels. Nitrogen fertilizer level @ 80 kg ha^{-1} in two split application, 25% at sowing and 75% at flowering time proved effective in improving the quality of peas.

Key Words: Pea; Split application of N levels; Quality

INTRODUCTION

Pea (*Pisum sativum* L.) belongs to the family leguminoseae. It is a cool season, self-pollinated and hardy tendril climbing plant. It is grown primarily for edible pods. In addition to its nutritional value (Baloch *et al*., 1994), it is rich source of protein, good source of vitamins A, B and C, and also contains a high proportion of minerals. Howard *et al*. (1962) reported that yield and quality of pea decreased with increase in nitrogen above 50 kg ha^{-1}. Shavelve (1973) stated that grain protein content increased linearly as the N rate increased. Similarly Lysenko (1980) reported that foliar spray of 15 L N as urea at the end of vegetative growth of pea increased the seed protein content by 4.2%, while in case of application to leaves was accumulated in globulins. El-Mansi *et al*. (1982) reported that four nitrogen levels i.e. (0, 15, 30 & 45 kg $feddan^{-1}$) when applied maximum results were obtained with highest level of N @ 45 kg $feddan^{-1}$. Saimbhi and Grewal (1986) stated that with N: P at 50: 30 kg ha^{-1} gave the highest yield of 70 q ha^{-1} compared with 33 q ha^{-1} in the non-fertilized control. Michaloic (1997) reported that the highest seed yield and best seed quality were obtained by an application of 40 kg N and 150 kg K_2O_5 ha^{-1}. He further stated that the seed yield and best seed quality (determined as vitamin C, sucrose, macro and micro elements contents) was found by application of 40 kg N and 150 kg K_2O ha^{-1}. Ramachandra *et al*. (1998) reported that the application of NPK (37.5: 60: 50) gave significant performance in respect of plant height at harvest, days to initial flowering, number of branches $plant^{-1}$, number of pods, number of seeds pod^{-1} and yield. Ali *et al*. (2001) reported that the application of varying nitrogen fertilizer levels did not show significant effect on the seed germination percentage, period of flowering, number of pods per plant, number of seeds per pod and seed weight per pod. Further, no significant differences were found among the treatments for the said parameters. Higher nitrogen levels improved the plant height, plant dry bio-mass, pod weight and highest yield significantly. Highly significant results were obtained from the maximum nitrogen fertilizer level of 80 kg/ha for pod weight, plant height, plant dry bio-mass and yield per plot when applied into two split doses of 25% at sowing and 75% at flowering stages. Although it is a very important, valuable and nutritious vegetable but its method of N applications is much important for obtaining better quality of peas. This experiment was conducted to check various split application of nitrogen levels on the quality and quality contributing parameters of pea.

MATERIALS AND METHODS

The experiment was conducted at the experimental area of Horticulture Department, Faculty of Agriculture, Gomal University, D.I. Khan. The experiment was laid out in randomized complete block design (RCBD) with three replications. There were 9 treatment combinations each replicated (3) three times. Each plot size was kept 5 x 3 m^2, there were three beds in each treatment of 1 m wide and 5 m length with maintaining 1 m bed to bed distance and 30 cm plant to plant distance. Nitrogen @ 40 and 80 kg ha^{-1} applied in two and four split doses in different proportions i.e. 50% at sowing + 50% at flowering; 25% at sowing + 75% at flowering; 75% at sowing + 25% at flowering and 25% at sowing + 25% after one month + 25% at flowering + 25% at first picking. Phosphorus and potassium was applied at the rate 90 kg ha^{-1} in the form of triple super phosphate and potassium sulphate as basal dose; whereas, N was applied in the form of urea according to the following

eight treatments with one control.

Treatments	Levels of N (kg ha^{-1}) Application	Frequency
T1	00	Control
T2	40	50% (at sowing); 50% (at flowering)
T3	80	50% (at sowing); 50% (at flowering)
T4	40	25% (at sowing); 75% (at flowering)
T5	80	25% (at sowing); 75% (at flowering)
T6	40	75% (at sowing); 25% (at flowering)
T7	80	75% (at sowing); 25% (at flowering)
T8	40	25% (at sowing); 25% (after one month); 25% (at flowering) and 25% (at1stpicking)
T9	80	25% (at sowing); 25% (after one month); 25% (at flowering) and 25% (at 1stpicking)

All the cultural practices such as irrigation, weeding, insect pest and disease control etc. were given uniformly.

The variety under test was P - 48. Data were recorded on physical characteristics i.e. (germination percentage, plant height (cm), leaf size, number of pods per plant, number of seeds per pod, weight of pods per plant (gm), grain weight (100 seed) and yield per plot) and chemical characteristics i.e. (moisture content, protein content, & ash content percentages). The analysis was performed by use of ANOVA techniques (Steel & Torrie, 1984), while DMR test (Duncan, 1955) was used to check the differences among the treatment means.

RESULTS AND DISCUSSION

Germination percentage of seeds. The data for % germination of seeds (Table I) shows non-significant for varying fertilizer levels. However, higher percentage of germination (89.67%) was recorded in T_2 at N level of 40 kg ha^{-1} in two split applications (50% at sowing & 50% at flowering) whereas the lowest percentage of germination (77.67%) was recorded in case of T3 with two split application of N levels (50% at sowing & 50% at flowering). Statistically the results among the treatments were at par with each other. These results revealed that neither high nor low application of nitrogen fertilizers had any significant effect on the germination percentage of Pea seeds. Ali *et al.* (2001) also observed the non-significant behavior of Nitrogen fertilizers towards germination of pea seeds.

Days to appearance for first flower. The non-significant data pertaining to number of days taken to appearance of first flower is presented in Table I. According to the data a period as maximum as (88.7) days were recorded at a fertilizer level of 80 Kg N/ha with four split applications of 25% at sowing, 25% after one month, 25% at flowering and 25% at first picking; whereas, minimum period of days (83.7) was recorded at a fertilizer level of 40 Kg N/ha with two split applications (75% at sowing & 25% at flowering). El-Mansi *et al.* (1982) reported the similar results that high nitrogen levels delayed the maturity of three pea cultivars. Further the results are also supported by Yadav *et al.* (1996), who reported that 0 - 40 kg N/ha application increased the number of days to flowering and marketable maturity.

Plant height (cm). The data regarding the plant height as influenced by various levels of nitrogen fertilizer is given in Table I. The results revealed that the plant height was significantly affected by varying nitrogen fertilizer levels. It is apparent from the data that the plants of maximum height (75.9 cm) were obtained at a fertilizer level of 80 kg N/ha with two split applications 25% at sowing and 75% at flowering, which was statistically at par with the fertilizer level, 80 kg N/ha with two split applications 50% at sowing and 50% at flowering with an average plant height of 75.7 cm. Minimum figure for plant height (55.0 cm) was noticed in control plots where no fertilizer level was applied. This increase and development in plant height under higher fertilizer levels was chiefly associated with the availability of optimum and adequate quantities of nitrogen in the soil in addition to the external sources and by direct fixation of atmospheric nitrogen from the atmosphere by the plants. The results further proved that nitrogen is the key and vital component for growth of pea crops and it can be seen from the results that as the nitrogen levels increased there was a remarkable improvement in plant height. These results are in line with Lysenko (1980), who reported that application of nitrogen as urea with increased dose was effective and increased plant height. El-Beheidi (1982) reported that varieties were widely different in plant height, and in some varieties fertilizer levels affected the plant height.

Leaf size (cm). The data (Table I) indicated non-significant variations for varying levels of nitrogen. However, the greatest leaf size (7.55 cm) was observed in fertilizer level of 40 kg ha^{-1} in two split doses (50% at sowing & 50% at flowering) whereas the shortest leaf size (6.10 cm) was noted in fertilizer level of 40 kg ha^{-1} with two split applications (75% at sowing & 25% at flowering).

Number of pods per plant. The statistically non-significant data regarding the number of pods per plant is presented in Table II. However, the maximum number of pods per plant (67.6) was harvested at fertilizer level of 80 Kg N/ha with two split applications 50% at sowing and 50% at flowering, whereas the lowest number of pods per plant (26.8) was recorded under control plots to which no artificial fertilizer was applied. This increased number of pods per plant under higher fertilizer levels was mainly linked with increased plant height, which was the result of nitrogen availability in the soil in adequate quantities from external sources that were applied. Woyke and Rzymowska (1986) reported that increasing dose of nitrogen (0, 80, 160 kg per hectare) increased the number of pods. Lysenko (1980) also confirmed the present findings and reported that increase in dose of nitrogen was effective and increased pods per plant.

Number of seeds per pod. The non-significant data regarding the number of seeds per pod is presented in Table

Table I. Effect of different levels of Nitrogen and different pickings on the germination percentage, plant height (cm), days to appearance of 1st flowering, leaf size (cm), of Pea

Different Nitrogen Levels	Germination % age	Plant height (cm)	Days to 1st flowering	Leaf size (cm)
T1 (Control)	81.83 NS	55.0 d	85 NS	7.29 NS
T2 = 40 Kg/ha with, 50 % (A.S); 50 % (A.F)	89.67	71.9 abc	86.7	7.55
T3 = 80 kg/ha with, 50 % (A.S); 50 % (A.F)	77.67	75.7 a	84.0	6.71
T4 = 40 kg/ha with, 25 % (A.S); 75 % (A.F)	78.67	66.1 c	87.0	6.16
T5 = 80 kg/ha with, 25 % (A.S); 75 % (A.F)	80.50	75.9 a	87.0	6.41
T6 = 40 kg/ha with, 75 % (A.S); 25 % (A.F)	79.00	70.8 abc	83.7	7.32
T7= 80 kg/ha with, 75 % (A.S); 25 % (A.F)	84.00	71.6 abc	85.7	6.10
T8 = 40 kg/ha with, 25% (A.S); 25% (A.1.M); 25% (A.F) and 25% (A.F.P)	79.00	67.6 bc	85.7	7.19
T9 = 80 kg/ha with, 25% (A.S); 25% (A.1.M); 25% (A.F) and 25% (A.F. P)	79.17	74.5 ab	88.7	6.23

NS = Non Significant
Means followed by different letter (s) are significant at 5 % level of probability.
A.S= at sowing, A.F = at flowering, A.O.M= after 1 month and A.F.P= at first picking

Table II. Effect of different levels of Nitrogen and different pickings on the number of pods per plant, number of seeds per pod, weight of pods per plant and grain weight (100 seed) (gm) of Pea

Different Nitrogen Levels	No. of Pods per Plant	No. of seeds per pod	Weight of pods per plant	Grain weight (100 seed)
T1 (Control)	26.80 N.S	3.95 N.S	47.54 c	37.02 NS
T2 = 40 Kg/ha with, 50 % (A.S); 50 % (A.F)	48.82	3.63	72.76 bc	35.63
T3 = 80 kg/ha with, 50 % (A.S); 50 % (A.F)	67.61	4.14	115.09 a	36.67
T4 = 40 kg/ha with, 25 % (A.S); 75 % (A.F)	41.91	4.25	66.26 bc	37.55
T5 = 80 kg/ha with, 25 % (A.S); 75 % (A.F)	51.88	3.99	115.66 a	34.92
T6 = 40 kg/ha with, 75 % (A.S); 25 % (A.F)	59.86	4.08	99.60 ab	36.38
T7= 80 kg/ha with, 75 % (A.S); 25 % (A.F)	58.61	4.23	94.17 ab	36.15
T8 = 40 kg/ha with, 25 % (A.S); 25 % (A.1.M); 25 % (A.F) and 25 % (A.F. P)	46.69	3.81	72.15 bc	33.40
T9 = 80 kg/ha with, 25 % (A.S); 25 % (A.1.M); 25 % (A.F) and 25 % (A.F. P)	48.66	4.04	69.84 bc	36.02

NS = Non Significant
Means followed by different letter (s) are significant at 5 % level of probability.
A.S= at sowing, A.F = at flowering, A.1.M= after 1 month and A.F.P= at first picking

II. The results revealed that maximum number of seeds per pod (4.25) was observed at 40 kg N/ha fertilizer level with two split applications 25% at sowing and 75% at flowering. While the minimum number of seeds per pod (3.63) was noted at a fertilizer level 40 kg N/ha with two split applications 50% at sowing and 50% at flowering stage. This character seems to be a varietal character as it has been reported unaffected by any N and P fertilizer levels in the previous literature. Ahmad (1973) and Ali *et al*. (2001) reported the results similar to that of present research studies, in which they mentioned that N levels showed no positive effect on number of seeds per pod.

Weight of pods per plant (g). The data pertaining to weight of pods per plant is an important character, which contributes considerably towards final yield. The data regarding pod weight per plant is given in Table II. It is obvious from the recorded data that maximum weight of pods (115.66 g) was obtained at fertilizer level of 80 kg N/ha with two split applications 25% at sowing and 75% at flowering stage, which was at par with the fertilizer level 80 kg N/ha with two split applications 50% at sowing and 50% at flowering with 115.09 g average weight of pods per plant. The lowest weight of pods (47.54 g) per plant was achieved under control plots where no fertilizer level was applied. This increased weight of pods per plant under higher fertilizer levels was mainly associated with improved plant height, increased pod numbers, length of pods and higher number of seeds per pod, which all had direct or indirect individual effects on pods weight per plant. These results are further supported by Lysenko (1980) and Novikova *et al.* (1986). They were of the opinion that increased nitrogen fertilizer levels had positive and significant effect on yield contributing characters of peas. Sangha *et al.* (1972) reported that pod weight per plant having a positive and highly significant correlation with the use of NPK fertilizers. Ahmad (1973) reported that there was increase in weight of pods per plant when NPK fertilizer was applied to pea crop.

Grain weight (100 seeds) (g). The data on the grain weight (100 seed) is shown in Table II, which reveals non-significant influence. However, the heaviest grain weight (37.55 g) was produced in fertilizer level of 40 kg ha^{-1} with two split applications (25% at sowing + 75% at flowering). The lowest grain weight (33.40 g) was observed in fertilizer level 40 kg ha^{-1} at four split doses (25% at sowing, 25% after one month, 25% at flowering, & 25% at 1^{st} picking).

Yield per plot (g). The data presented in Table III showed that the effect of different nitrogen fertilizer levels had highly significant effects on green pod yield per plot. It is evident from the results that highest pod

Table III. Effect of different levels of Nitrogen and different pickings on the yield per plot (gm), moisture content % age, protein content % age and ash % age of Pea

Different Nitrogen levels	Yield per plot (gm)	Moisture %	Protein %	Ash %
T1 (Control)	2344.26 c	63.33 NS	11.5 a-c	1.63 ab
T2 = 40 Kg/ha with, 50 % (A.S); 50 % (A.F)	4082.50 b	61.17	21.2 ab	1.85 a
T3 = 80 kg/ha with, 50 % (A.S); 50 % (A.F)	5226.03 ab	59.50	17.1 ab	1.45 bc
T4 = 40 kg/ha with, 25 % (A.S); 75 % (A.F)	4158.56 b	61.67	28.0 a	1.49 bc
T5 = 80 kg/ha with, 25 % (A.S); 75 % (A.F)	6270.00 a	61.83	16.8 ab	1.70 ab
T6 = 40 kg/ha with, 75 % (A.S); 25 % (A.F)	4664.90 b	60.00	10.0 bc	1.25 c
T7= 80 kg/ha with, 75 % (A.S); 25 % (A.F)	5179.20 ab	61.17	14.5 a-c	1.61 ab
T8 = 40 kg/ha with, 25 % (A.S); 25 % (A.1.M); 25 % (A.F) and 25 % (A.F. P)	4083.53 b	61.17	11.3 a-c	1.70 ab
T9 = 80 kg/ha with, 25 % (A.S); 25 % (A.1.M); 25 % (A.F) and 25 % (A.F. P)	3700.26 bc	66.50 NS	12.2 a-c	1.35 bc

NS = Non Significant

Means followed by different letter (s) are significant at 5 % level of probability.

A.S= at sowing, A.F = at flowering, A.O.M= after 1 month and A.F.P= at first picking

yield per plot (6270.00 g) was recorded at fertilizer level of 80 kg N/ha when applied 25% at sowing and 75% at flowering, followed by 5226.03 and 5179.20 g in the fertilizer levels of 80 kg N/ha when applied 50% at sowing and 50% at flowering and 80 kg N/ha when applied 75% at sowing and 25% at flowering, respectively. Both of these fertilizer levels were at par to each other. Like-wise the lowest yield of pods 2344.26 g per plot was received in control plots, where no fertilizer was applied. The results revealed that the application of high dose of fertilizer levels can attribute better and continuous supply of nutrients to the plant during growth and development consequently increase the yield. At lower dose the nutrients were not available to plants in sufficient quantities which ultimately resulted in poor yield. El-Mansi *et al.* (1982) and Woyke and Rzymowska (1986) reported that increasing dose of nitrogen (0, 80, 160 kg N/ha) had positive affect on the yield. Novikova *et al.* (1986) and Lysenko (1980) were also of the opinion that increase in nitrogen increases yield of peas.

Protein content (%). Data regarding to protein content (Table III) revealed significant differences for varying levels of nitrogen and different pickings. The maximum protein content percentage (28.0%) was obtained in fertilizer level of 40 kg ha^{-1} with two split applications of nitrogen fertilizers (25% at sowing & 75% at flowering), closely followed by fertilizer levels of 40 kg N/ha when applied 50% at sowing and 50% at flowering and 80 kg N/ha when applied 50% at sowing and 50% at flowering and 80 kg N/ha when applied 25% at sowing and 75% at flowering with percentage of 21.2, 17.7 and 16.8, respectively. All these three levels of Nitrogen fertilizers were statistically at par to each other. The least protein content (10.0%) was recorded in T_6 at a level of nitrogen of 40 kg ha^{-1} with two split applications (75% at sowing & 25% at flowering). The results are agreed with Lysenko (1980), who reported that there was increase in the protein content in pea when Nitrogen was applied in the end of the vegetative growth period.

Moisture content (%). The data recorded for moisture content % are presented in Table III shows that the results for nitrogen levels indicated non-significant behaviour However, highest moisture content 66.50% was noted in fertilizer level of nitrogen 80 kg ha^{-1} (25% at sowing, 25% after one month, 25% at flowering & 25%), where as the minimum moisture content (59.50%) was noticed in fertilizer level of 80 kg N ha^{-1} with two split doses (50% at sowing & 50% at flowering). These results don't agree the findings of Khan (1995), who reported 97.4% moisture in edible portion of pea.

Ash content (%). Data on ash percentage expressed significant differences (Table III) for different nitrogen levels on pea. The maximum ash (1.85%) was recorded in fertilizer level of 40 kg ha^{-1} (50% at sowing & 50% at flowering), followed by 40.0 kg ha^{-1} (25% at sowing + 25% after 1 month + 25% at flowering + 25% at first picking), 80.0 kg ha^{-1} (25% at sowing + 75% at flowering), control and 80.0 kg ha^{-1} (75% at sowing + 25 % at flowering) with 1.70, 1.70, 1.63 and 1.61 % ash, respectively. All these four treatments were statistically at par with each other. While minimum ash (1.25%) was noticed in fertilizer level of 40 kg ha^{-1} (75% at sowing & 25% at flowering).

Recommendations. To get the better plant growth and higher fresh pod yield, 80 kg N/ha in two split applications, 25% at sowing and 75% at flowering is recommended for agro-climatic conditions of Dera Ismail Khan.

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