# EFFECT OF DIFFERENT DOSES OF NITROGEN AND SOWING DATE ON THE YIELD OF PEA

**By**


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# CERTIFICATE

This is to certify that thesis entitled, *"Effect of different doses of Nitrogen and Sowing date on the yield of Pea."* Submitted to the Department of Soil Science, Sher-e-Bangla Agricultural University, Dhaka in partial fulfillment of the requirements for the degree of *MASTER OF SCIENCE (M.S.)* in *SOIL SCIENCE* embodies the result of a piece of *bona fide* research work carried out by *NIGER SULTANA* Registration No. **1533** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that such help or source of information, as has been availed of during the course of this investigation has duly been acknowledged by her.

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DEDICATED TO
MY
BELOVED PARENTS

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## ABSTRACT

A field experiment was conducted at the Sher-e-Bangla Agricultural University farm during the period from November, 2005 to February, 2006, to find out the optimum levels of N and sowing date for maximum yield of pea. There are 18 treatments combinations comprising of four levels of N (0, 30, 60 and 90 kg N $ha^{-1}$), one fully organic and another one control. The treatments were: $T_1$ = Control, $T_2$ = 30 kg N/ha, $T_3$ = 60 kg N/ha, $T_4$ = 90 kg N/ha, $T_5$ = PKS but no N, $T_6$ = Organic. A common dose of 75 kg $P_2O_5$ $ha^{-1}$, 60 kg $K_2O$ $ha^{-1}$, Gypsum 10 kg $ha^{-1}$ and $ZnSO_4$ 2 kg $ha^{-1}$ were applied to all plots except control and organic plots. There were three sowing date, November 18th, November 28th, 2005 and December 10th, 2006. The maximum plant height (41.53 cm), highest number of branches/plant (4.62), highest yield of green pod (7.64 t/ha), highest number of pods $plant^{-1}$ (8.33), highest matured seed yield (2.02 t/ha), were recorded under the treatment 90 kg N $ha^{-1}$ as well as at the sowing date November 28. The yields due to different treatments ranked in the order of $T_4>T_3>T_2>T_5>T_6>T_1$. The interaction effect of sowing date and different doses of fertilizer showed statistically significant difference in consideration of green pod yield, matured seed yield and non significant effect on plant height, number of pods $plant^{-1}$ etc. The maximum NPK content in plant tissue were recorded at the sowing date November 28. From the viewpoint of yield and nutrient content of garden pea and the nutrient requirement of the crop, the N, P and K combination at the rates of 90 kg N, 75 kg $P_2O_5$ and 60 kg $K_2O$ /ha was considered to be the balanced combination of fertilizer and 28th November, is the optimum sowing date for the maximum output through cultivation of pea in Deep Red Brown Terrace Soil of SAU farm.

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# ABSTRACT

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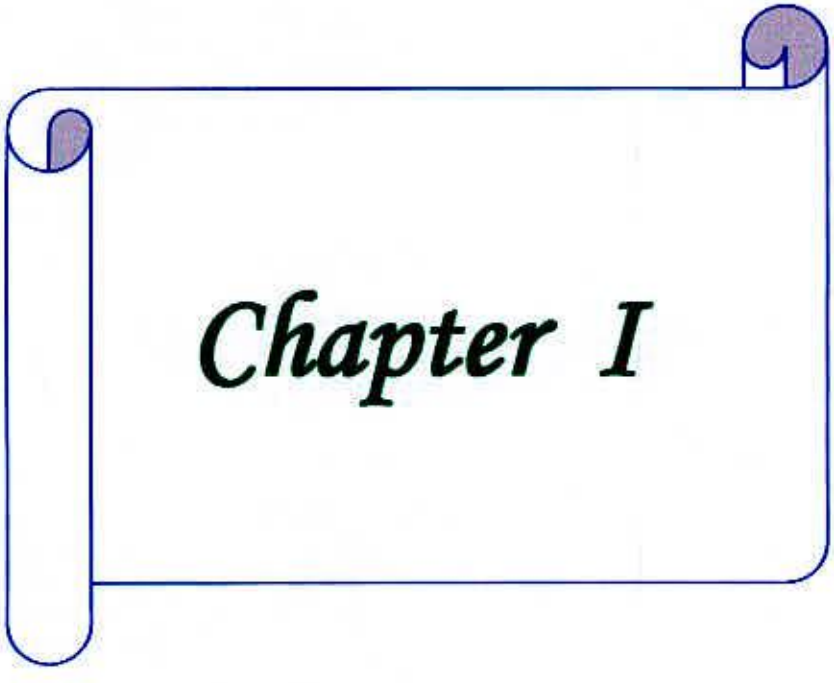

Chapter I

# INTRODUCTION

The pea (*Pisum sativum)* is a spreading herbaceous annual self-pollinated legume crop, under sub-family Papilionideae belonging to the family leguminosae. Pea is a cold climatic crop. It can be grown in tropical areas at high altitudes of up to 2700 m and during cold winter months in the sub tropics. The crop is reported to perform better in sub tropical areas having a winter cold period of five month duration (Makasheva, 1983). Rice-wheat combinations have always predominated the traditional diets of the people of Bangladesh. Rice and wheat are grown on the more productive lands, leaving the pulses to the marginal land. However, emphasis on cereal production in official food policies has led to the negligence of production of pulses in recent years. It has reduced the per capita availability of protein. The pea is grown mainly for green pods and seeds are used as vegetables. Matured seeds can be used for preparing delicious foods. Cultivation of this crop is highly profitable and attractive to the farmers for its short durability and high market value. It takes about 60 to 65 days from sowing to its green pod harvest and 70 to 80 days for matured seed harvest. Inclusion of peas in crop rotation helps to improve soil fertility and yield of succeeding crops (Rana and Sharma, 1993). It is also attractive to the farmers for its agronomical value. As a nitrogen fixing crop with a high assimilating capacity of roots, it utilizes the chemical compounds which are low in solubility and rarely accessible to cereals from the

cultivated soil layer to deeper layers. As a preceding crop, pea facilitates the efficiency of using utilization of organic matter by subsequent crops, especially grain and cash crops. In Bangladesh, it can be grown successfully after the harvest of transplanted aman or jute crops. The biomass of pea can be used as green manure, which can increase both nitrogen and organic matter content of the soil.

The pea is grown mainly for young pod to get tender green seeds as vegetables. The matured seeds can be used for preparing 'dal' or 'chatpati' and other delicious foods. For its high nutritive value and sumptuous taste, it has gained popularity. Green pea is rich in vitamin and protein. Matured seed contains 9-15% water, 18-35% protein, 4-10% sugar, 0.6-1.5% fat, 2-10% cellulose and 2-4% minerals (Makasheva, 1983). Pea contains most of the amino acids. After the main produce is used, the waste material of pea, still reach in protein, can serve as a reserve for improving the quality of animal feeds.

Successful production of pea depends on various factors. Date of sowing, fertilizer dose etc are the most important factors which assure better crop production. As the demand of green pea is increasing day by day and the farmers also want to ensure the high price by marketing it as early as possible. The experimental pea variety is a short durable variety and if it is suitable for early winter, it will be considered as a very much profitable crop to the farmers. Pea responds greatly to major essential nutrient elements like nitrogen, phosphorous and potassium in respect of its growth and yield. On the other hand, manure like cow dung when applied helps

maintain good soil structure besides being a continuous source of nutrient. However, in soils having low organic matter and N content, the addition of fertilizer at the rate of 15-30 kg N/ha has been found to be beneficial (Mclean *et al*, 1974; Sonia, 1974; Ahmed and Shafi, 1975; Thevino and Murray, 1975; Foutes *et al*, 1979). The green pod yield increases with increasing rate of N application up to 40 kg N /ha (Bhopal and Singh, 1990). Significant yield response to the addition of 36 to 90 kg $P_2O_5$ /ha were reported (Sen and Kavitkar, 1958; Singh, 1995).

It is imperative that an optimum dose of nitrogen and sowing time of pea should be determined for its better production. This experiment was therefore, undertaken with the following objectives:

1. To study the growth and yield performance of pea based on different sowing date.
2. To study the growth and yield of pea by using different doses of N fertilizer.
3. To study the interaction effect of different sowing time and doses of N on the yield and yield contributing characters of pea.

# Chapter II

# REVIEW OF LITERATURE

Different aspects of the present investigation have been reviewed under the following heads:

## 2.1 Effect of nitrogen on yield and yield attributes of pea

Inoculation with efficient strain of *Rhizobium* may be sufficient to meet the requirement of N in normal soils. However, in soils having low organic matter, low N-content, the addition of fertilizer N at the rate of 15-30 kg/ha has been found to be beneficial (McLean *et al.*, 1974, Sonia, 1974, Ahmed and Shafi, 1975). This is to help the crop establishment in its earlier growth stage before the nodules start fixing nitrogen. Tej Singh *et al.* (1975) concluded from different experiments that low dose of N (15-25 kg/ha) combined with moderate increments of P (40-60 kg $P_2O_5$/ha) produced higher grain yield in mungbean.

Lysenko (1981) concluded that a foliar spray with $N^{15}$ (as urea or ammonium nitrate) at the end of the vegetative growth period of pea increased the seed protein contents by 4.2% and $N^{15}$ applied to leaves was accumulated in globulins. He also observed that N as urea was more effective than N as ammonium sulphate.

Koylijarvi (1986) investigated the effect of different N fertilizer rates (0-120 kg N/ha) and inoculation with *Rhizobium* on peas and pea/oat mixture. He reported

that increased in N rate up to 100 kg/ha increased seed yield and the highest yield (av. 2.03 t/ha) were obtained with 50 kg N.

Sinha *et al.* (1986) conducted an experiment with a pea/maize cropping sequence, seed inoculation with Rhizobium or phosphobacteria and/or application of 30-90 kg $P_2O_5$/ha to peas increased the N fixation in soil and N, P and K uptake by the crop. Data on the effects of the treatments on N, P and K uptake by the crop. Data on the effects of the treatments on N, P and K uptake by the succeeding maize crop are given. The positive balance of N and available P in soil after peas became negative after maize.

Simon (1986) conducted an experiment of pea with 0, 30, 60 and 100 kg N/ha. They concluded that yield sometimes decreased at high N rates.

Salinas *et al.* (1987) conducted an experiment on Pea cv. SP-290, which was grown in nutrient culture at 0, 0.5, 2.0 or 8.0 ppm B and 125, 250, 500 or 1000 ppm N but when B was yield limiting N rate had no influence on B toxicity. B accumulation in leaves, roots and shoots, but not in pods, increased as B increased. B + N treatments produced variation in plant mineral composition but values were considered to be within the normal range for peas with the exception of those of B and N. It was concluded that yield reductions were directly attributable to B and N treatment.

Cebula *et al.* (1987) conducted an experiment of pea with N at 40 or 80 kg/ha as ammonium nitrate was applied pre-sowing or post-emergence and the effects of the treatments on available soil N ($NH_4$ and $NO_3$), yield and quality parameters of the dwarf cv. Bordi and the vigorous cv. Nike were investigated. The 2 cultivars responded similarly, with only a slightly higher soil N being found under Nike, which had a larger root system. Crop yield and quality were not influenced significantly by the treatments and lower protein content in fresh seeds of Bordi was noted only in the untreated control. Elneklawy *et al.* (1988) reported that the application of 60 kg N/ feddon or seed inoculation with a local inoculum (Okadin) or an introduced inoculum (TAL) increased N uptake and green pod yield. They also found that 15 kg N/ feddon plus TAL increased seed yields [1 feddon = 0.42 ha].

Pachauri *et al.* (1988) in a 2 years trial with garden pea cv. Lincoln applied N at 0, 37.5 or 75 kg/ha, $P_2O_5$ at 0, 75 and 150 kg/ha and $K_2O$ at 0, 50 and 100 kg/ha. A basal dose of FYM was applied at 5q/ha. The highest seed yield was obtained on the plots receiving N: $P_2O_5$:$K_2O$ at 75: 150:50 kg/ha, respectively.

Deschamps and Wery (1989) concluded that irrigation and or N application increased DM production more markedly in chickpea than in peas. Both chickpea and Pea received 40 kg N/ha which were applied in 3 split doses. Saimbhi and Grewal (1989) conducted a field experiment with a new pea cultivar (Harabonna) by applying N at the rates of 0, 25 and 50 kg/ha from three sources (viz. calcium

ammonium nitrate, urea and ammonium sulphate), $P_2O_5$ at 30 and 60 kg/ha in all possible combinations with N. They observed that the sources of N had no appreciable effect on the indices studied but the rate of N and P at 50:30 kg/ha gave the highest yield of 70q/ha compared with 33.3q/ha in the non fertilized control. Naik (1989) also found that, the closest spacing and N and P at the highest rates resulted in the highest yields but no appreciable response to K was observed.

Bhopal and Singh (1990) conducted an experiment with the semi dwarf garden pea cv. Lincoln, received N at the rate of 0, 20, 40 and 60 kg/ha and $P_2O_5$ at 0, 30, 60 and 90 kg/ha with $K_2O$ at 30 kg/ha. They concluded that the mean green pod yield increased with increasing N rates up to 40 kg/ha (1.57 t/ha) and then decreased at 60 kg/ha. Vigorous vegetative growth was attributed at the highest N rates. Simon (1990) in a pot trial used 5 *Rhizobium* strains on 3 new and one local varieties of garden pea. Inoculation with selected strains in most cases increased seed yield as compared to the use of unselected native Rhizobia. There were significant differences between different variety and Rhizobial strain combinations. High TNA (total nitrogenase activity) was accompanied by high plant biomass but failed to improve seed yield.

Vijai *et al.* (1990) carried out an experiment with garden pea cv. Bonneville showed that increasing rates of N or P application significantly increased growth and pod yield. At the highest rates of N and $P_2O_5$ application (45 and 80 kg/ha,

respectively) showed the best performance in terms of yield and yield attributes of garden pea.

Sati *et al.* (1991) conducted an experiment in loam soils having pH-7.4 by using N fertilizer in different ways as (a) 25 kg/ha as basal dressing, (b) 15 kg/ha as basal application + 10 kg/ha as top dressing, (c) 15 kg/ha as basal + 10 kg/ha as a foliar spray and (d) only seed inoculation. They did not find any significant variation on yield and yield attributes of pea (cv. Arkel) by imposing the different treatments. However, inoculation increased the nodulation significantly, but did not favour the growth or yield of pea.

Azad *et al.* (1992) conducted an experiment with field pea cv. PG-3 on soils having organic matter contents of 0.19, 0.38 or 0.44% with varying N levels of 0, 15, 30, 37 or 45 kg/ha. Yields without N were 1.97, 1.28 and 1.35 kg seed/ha on the 3 soils respectively, while yields at the highest N rates were 2.94, 2.05 and 2.09 t/ha. Response to applied N decreased with increasing soil carbon.

Singh *et al.* (1992) reported that field pea cv. Rachna, receiving N-P-K-Zn at the rate of 18-46-40-25 kg/ha gave the highest grain yield of 2.97 t/ha in 1983-84 and 3.16 t/ha in 1984-85. The highest net return was obtained with application of 46 kg P/ha. Addition of N fertilizer to soil had favored the yield of cowpea (Tizon 1968; Worley *et al.* 1971). Rahman and Quasem (1982) reported that under Bangladesh condition N addition up to 60 kg/ha gave the positive response in cowpea.

Negi (1992) carried out an experiment with vegetable pea at 4 levels of N (10, 20, 40, 60 kg/ha) and 3 of P (0, 60, 120 kg $P_2O_5$/ha). He reported that the highest green pod yield could be obtained at the N rate of 20 kg/ha. A combination of 20 kg N and 60 kg $P_2O_5$/ha produced yield up to 1.72 t/ha. Agarwal and Kumar (1993) reported that lentil plants inoculated with *Rhizobium* fixed more atmospheric N and produced significantly higher yield attributes and grain yield than in uninoculated plant. They also obtained significantly higher grain yield at the rate of 20 kg N/ha compared with that in the control.

O-Conner *et al.* (1993) reported that early sowing increased $N_2$ fixation by as much as 96 kg N/ha compared with late sowing. They also concluded that early sowing improved the probability of peas contributing to soil total N.

Rana and Sharma (1993) conducted a field experiment on sandy loam soil with direct seeded upland rice (cv. Govind) in Kharif season on the same plots where chickpea (cv. Pg-114), field Pea (cv. Azad P-1), lentil (cv. PL 406) and wheat (cv. HD 2329) were grown in previous winter. Rice was given 0, 40, 80 or 120 kg N/ha. The highest rice equivalent yield obtained in the field pea rice cropping system. Pkalita *et al.* (1994) reported that foliar spray of 2% N at first flowering and post flowering stages of pea produced significantly higher yield in the treated plot compared with the control. They also concluded that N stress both at

flowering and pod filling stages was likely responsible for decline in yield performance of pea.

Bahl *et al.* (1995) conducted an experiment with peas cv. PG 3 were given 0-60 kg N and 0-60 kg $P_2O_5$/ha. Application of 40 kg N and 30 kg $P_2O_5$/ha was optimum for seed yield and N and P uptake. Nitrogenase activity was decreased by 40 and 60 kg N/ha, particularly at 0 and 30 kg $P_2O_5$/ha.

Singh *et al.* (1995) conducted an experiment on the performance of 29 cowpea (*Vigna unguiculata*) genotypes, grown under zero and 120 kg N/ha applied in two equal splits, were evaluated with respect to their nodulation and nitrogen assimilating characteristics. Nitrogenous fertilization treatments, in general, inhibited not only nodulation capacity but also nodule growth. There was an increase in the nodule and root nitrate reductase activity in fertilizer-treated plants. However, in general, no nitrite accumulation was observed. Varieties EC240890 and EC170606, which exhibited good nodulation and desirable metabolic characters under the fertilizer treatment, and are recommended for use in cereal-based intercropping systems.

Saini and Thakur (1996) conducted a field experiment during the summer seasons of 1990-91, at Leo with peas cv. Lincon and given 0-60 kg N and 0-66 kg P/ha. Mean green pod yield increased with up to 30 kg N (17.4 t/ha) and was the highest with up to 52.8 kg P. In a same kind of experiment by Michalojc (1997) found that

highest seed yield and best seed quality (as determined by vitamin C, saccharose and macro-and microelements contents) were obtained by applying 40 kg N.

Gangwar *et al.* (1998) from a field experiment on pea found that the contribution from fertilizer as a percentage of its nutrient content was 188.82, 20.79 and 46.57 for N, P and K, respectively.

Kushwaha (2001) conducted a field study involving four rates of N (0, 30, 60 and 90 kg/ha) and reported that the highest nitrogen use efficiency was with the application of 90 kg N/ha.

Uddin *et al.* (2001) conducted an experiment at BSMRAU farm in Bangladesh, from November 1997 to January 1998, and reported that the highest amount of crude protein of green seed was recorded under 40 kg N/ha. A row spacing of 30 cm along with the application of 60 kg N/ha was found to be the best combination for achieving the highest yield and quality of garden pea in salna soil services under Madhupur soil tract in Bangladesh.

Mishra (2002) carried out a field experiment and reported that the higher mean seed yield (3354 kg/ha) was obtained with 20 kg N /ha. The application of 40 kg N /ha under moisture stress at branching and flowering and no moisture stress treatments increased the yield by 29, 18 and 30% respectively.

Lal (2004) showed that the effects of N (at 0, 20, 40 and 60 kg/ha) and P (at 0, 30, 60 and 90 kg/ha) on the seed yield of pea cv. Arkel and French bean *[Phaseolus vulgaris]* cv. Contender and found that N at 40 kg/ha was optimum for obtain the maximum pea and bean seed yields.

Clayton *et al.* (2004) reported that the close proximity of a highly concentrated band of N fertilizer had a greater impact on nodulation and subsequent $N_2$ fixation than the residual soil N level under field conditions, soil applied inoculants improved N nutrition of field pea compared to seed applied inoculation with or without applied urea-N. Brkic *et al.* (2004) conducted an experiment by using different rates of N (0, 40, 80, 120 kg N/ha) during 1999-2000 on two soils (Mollic Gleysols and Eutric cambiosls) in Croatia, they reported that the effect of nitrogen fertilization was dependent on the soil type, i.e. its chemical properties. The highest seed yield nodule dry matter and seed protein content obtained from plants fertilized with 40 kg N/ha on Mollic Gleysols (3.96% humus) were 4.02 t/ha, 0.482 g/plant, and 26.91% respectively. The highest seed yield, nodule dry matter and seed protein content observed from plants grown on Eutric Cambisols (1.07% humus) with 80 kg N/ha were 3.65 t/ha, 0.456 g/plant and 26.48%, respectively.

**2.2 Effect of different sowing date on yield and yield attributes of pea.**

Salih and Ageeb (1987) reported that sowing date and plant population significantly affected root rot (Fusarium solani t.sp. fabae) and wilt (*F.*

*oxysporusing*) incidence. Disease incidence decreased with late sowing and yield was significantly higher.

Gesreva and Kostruski (1988) conducted an experiment in 1981-84, and found that fodder pea cv. Fatsima sown on 20 October and 20 November gave seed yields of 4.06 and 3.23 t/ha respectively.

Vonella *et al.* (1991) conducted an experiment, with 5 pea cultivars sown on 30 November, 20 December and 10 January. They reported that seed yields decreased from 2.77 t to 2.09 t/ha with increased delay in sowing. There was no significant difference between cultivars in seed protein content (average 24.48), which increased with increased delay in sowing.

Chatterjee *et al.* (1991) conducted an experiment on different sowing date and peas were sown in the second week of every month from January to December they reported that those sown between January and August failed to grow well or to produce seeds. This failure was attributed to powdery mildew mildew [*Erysiphe pisi*]. In a second experiment, with seeds sown only from Sep. to Dec., the plants raised from Oct. sowing achieved the greatest height (49.7 cm), number of pods (5.7/plant), seed yield (22.2 q/ha) and produced seeds with the highest germination percentage (88.0).

O'-Connor *et al.*, (1993) observed the DM, biomass N, $N_2$ fixation (determined by the 15N isotope dilution method), grain yield and grain N of 5 pea cultivars sown

on different dates at 6 sites in South East Australia. Earlier sowing (late April to early May) increased $N_2$ fixation (by as much as 96 kg N/ha compared with sowing in late June to early July). Early sowing improved the probability of peas contributing to soil total N. The potential increment in soil N from the pea stubbles left after harvesting, average over the varieties, was as high as 98 kg N/ha with early sowing and as low as -38 kg N/ha with late sowing. The benefits from earlier sowing were due to greater DM production with a higher N concentration and a greater proportion of plant N from $N_2$ fixation. Varietal variation in fixing N and potential for augmenting soil total N was generally smaller than the variation in these parameters due to different sowing dates.

Pirani *et al.* (1993) conducted an experiment in 1989-90 and 1990-91 in the Marches region of Italy, with pea cv. Pianello and Solara sowed that sowing in Nov.-Dec. produced greater yields than sowing in Jan. in both years. Early sowing meant that peas were at a less vulnerable stage when the parasitic developed and ensuring that peas did not follow a crop susceptible to orobanche reduced incidence of the parasite.

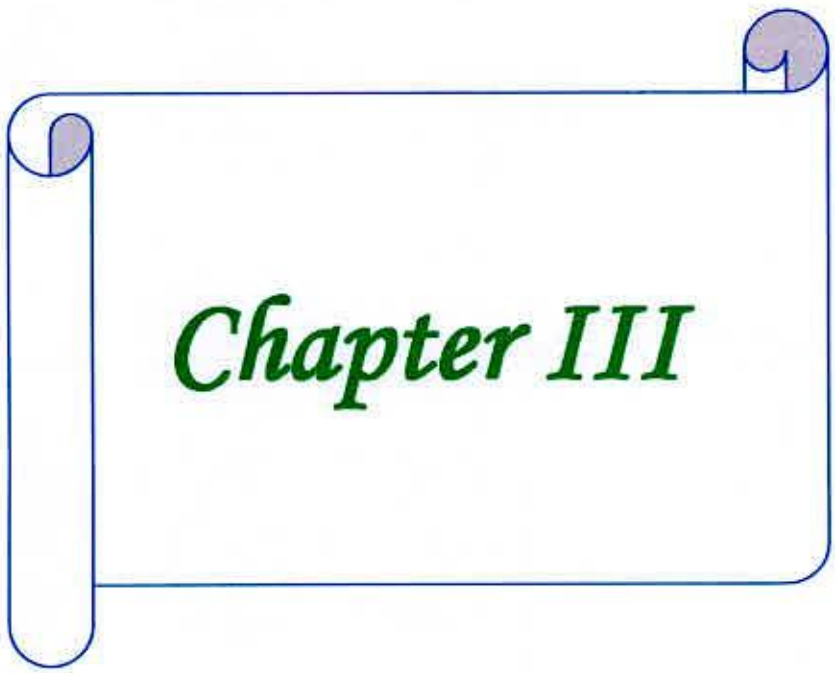
Castillo *et al.* (1994) concluded that time of sowing had no effect on the germination of the seeds produced, but did affect seed vigor as both conductivity and hollow heart were greater in seeds from the Nov. sown crop, and as a consequence, expected field emergence (EFE) was significantly lower. Seeds from the Nov. sowing encountered greater climatic extremes (temperature, rainfall, and

relative humidity) during their maturation in Jan. than seeds from the December sowing which matured in Feb.

Singh *et al.* (1995) conducted an experiment on pea that was sown on four different dates: 20 October, 5 and 21 November and 6 December in 1986-87 and 1987-88, they observed that October was the most suitable date of sowing as the infected plants, nodal leaves, compound leaves and area of infected compound leaves, were minimum weight. The maximum disease incidence resulting in low yields was in the December-sown crop.

From the experiment of Pap (1996) it was found that, the number of days from sowing to seedling emergence decreased with lateness of sowing from 30-35 days to 10 days as the growing season progressed. Similar decreases in the duration of later growth stages were observed with delay in sowing. There was no consistent trend of pea seed yield with sowing date in either year, except that yield was reduced by very late sowing.

Rai and Gupta (2003) conducted an experiment on the effects of sowing dates (20 October and 2 and 20 November) were investigated in faizabad, uttar Pradesh. India, in the rabi seasons of 1997-98 and 1998-99. The highest grain yield and low disease incidence were obtained with sowing on 5 November. Rust intensity was higher on crops sown during 20 November, compared to earlier dates.


Chapter III

# MATERIALS AND METHODS

The experiment was conducted at the Research Farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka during winter season of 2005 (November 05 to February 06). The experimental site was under the Agro Ecological Zone of Madhupur Tract (AEZ 28) and located at $23^0774'$ N latitude and $90^0335'$ E longitude with an elevation of one meter above sea level.

This chapter has been divided into a number of sub-heads described as below:

## 3.1 Experimental Details of the Site

### 3.1.1 SOIL

The soil of the experimental site belongs to the General Soil Type, Deep Red-Brown Terrace Soil, under Tejgaon cultivated series. Topsoil is clay loam in texture. Organic matter content is very low (0.82%) and soil pH varies from 5.8-6.0. The land is above flood level and well drained. The morphological, physical and chemical characteristics of initial soil are presented in Table 1 and 2.

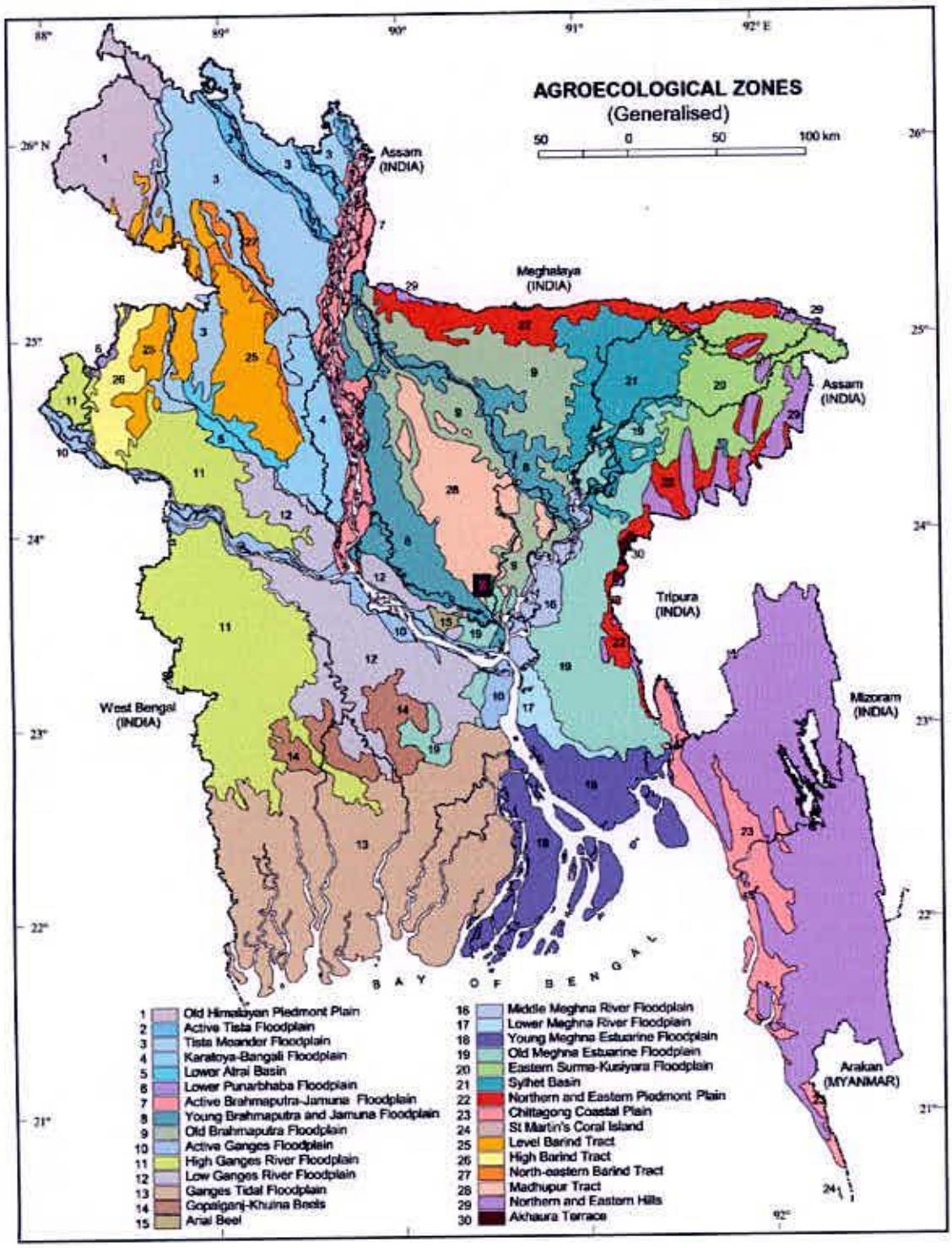



**Fig. 1. Map showing the experimental sites under study**

**Table-1 Morphological characteristics of experimental field.**

| **Morphological Features** | **Characteristics** |
|---|---|
| Location | Sher-e Bangla Agricultural University Farm, Dhaka |
| AEZ No. and name | AEZ 28, Modhupur Tract |
| General soil type | Deep Red Brown Terrace Soils |
| Soil Series | Tejgaon |
| Topography | Fairly leveled |
| Depth of Inundation | Above flood |
| Drainage Condition | Well drained |
| Land type | High land |

**Table-2 Basic properties of soil of the experimental plot.**

| Soil properties | Analytical data |
|---|---|
| **Particle size analysis.** | |
| % Sand | 29.0% |
| % Silt | 41.8% |
| % Clay | 29.2% |
| Soil texture | Clay loam |
| Soil pH | 5.8 |
| Organic matter (%) | 0.82 |
| Total N (%) | 0.08 |
| Available P(ppm) | 20 |
| Exchangeable K (me/ 100g soil) | 0.10 |
| Available S (ppm) | 40 |

### 3.1.2 Climate

The annual precipitation of the site is 2152 mm and potential evapotranspiration is 1297 mm, the average maximum air temperature is 30.34$^0$C and average minimum temperature is 21.21$^0$C. The experiment was carried out during the rabi season of the year, 2005. Temperature during the cropping period ranged between 12.20$^0$C to 29.2$^0$C. The humidity varied from 73.52% to 81.2%. The day length was reduced to 10.5-11.0 hours only and there was no rainfall from the beginning of the experiment to harvesting. The monthly average air temperature, relative humidity, and monthly total rainfall, pattern of the site during the experimental work are presented in Appendix Figures 9 to 11.

### 3.1.3 Crop

IPSA 1, a short duration and high yielding variety of pea, was used as a test crop. The variety was developed by the Genetics and Plant Breeding Department of Bangabandhu Sheikh Mujibur Rahman Agricultural University, Salna, Gazipur.

### 3.1.4 Land Preparation

The experimental field was first opened on 15 November, 2005, with the help of a power tiller; later the land was prepared very well by deep and cross ploughing with the tractor followed by harrowing and laddering up to a good tilth. All kinds of weeds and stubbles of previous crop were removed from the field. Drains were made around each plot and the excavated soil was used for raising the plots to about 10 cm high from the soil surface.

### 3.1.5 Design and experimental layout

The experiment was laid out in a randomized complete block design (RCBD) with three replications. Each replication consisted of 18 treatment combinations consisting of 6 treatments of fertilizer and three sowing dates. The dimension of each plot was 2.5 m X 2.0 m. Total number of plots were 54 (18 x 3), having plot to plot and block to block spacing 0.5 m and 1.0 m, respectively. Row to row and plant-to-plant spacing were 20 cm and 5 cm, respectively, accommodating 10 rows in each plot and 50 plants in each row. The different treatments were as follows:

Fertilizer treatments:

$T_1$ = Absolute control i.e. no application of any sources of plant nutrients

$T_2$ = Application of 30 kg. N / ha + PKS at Standard rates.

$T_3$ = Application of 60 kg. N / ha+ PKS at Standard rates.

$T_4$ = Application of 90 kg. N / ha+ PKS at Standard rates.

$T_5$ = O kg N/ha i.e. no application of N + PKS at Standard rates.

$T_6$ = Organic (Application of cowdung only at the rate of 10 t/ha and no application of N, P, K and S)

**Treatments of sowing dates:**

$D_1$ = 1st sowing date 18. 11. 05

$D_2$ = 2nd sowing date 28.11. 05

$D_3$ = 3rd sowing date 10. 12. 05

### 3.1.6 Collection of initial soil sample

Initial soil samples were collected before land preparation from 0-15 cm soil depth. The samples were drawn by means of an auger from different location covering the whole experimental plot and mixed thoroughly to make a composite sample. After collection of soil samples, the plant roots, leaves etc. were picked up and removed. Then the samples were air dried and sieved through a 10-mesh sieve and stored in a clean plastic container for physical and chemical analysis.

### 3.1.7 Application of fertilizers

A blanket dose of 75 kg $P_2O_5$, 60 kg $K_2O$ and 10 kg S per hectare were applied to all plots except $T_1$ and $T_6$ plots in the forms of triple super phosphate (TSP), muriate of potash (MP) and gypsum, respectively during final land preparation. Nitrogen was applied as per treatment in the form of urea in two equal splits. The first split was applied during land preparation; the second split was applied just before the flowering stage. Application rates of different fertilizers and cowdung are presented in Table 3.

**Table-3. Treatment combination with different fertilizers and cowdung**

| Treatment | N kg/ha | $P_2O_5$ kg/ha | $K_2O$ kg/ha | Cowdung t/ha |
|---|---|---|---|---|
| $T_1$(Control) | 0 | 0 | 0 | 0 |
| $T_2$ | 30 | 75 | 60 | 0 |
| $T_3$ | 60 | 75 | 60 | 0 |
| $T_4$ | 90 | 75 | 60 | 0 |
| $T_5$ | 0 | 75 | 60 | 0 |
| $T_6$ | - | - | - | 10 |

### 3.1.8 Date of emergence of seedling

Emergence of plant of 1st sowing date – 23 November, 05

Emergence of plant of 2nd sowing date – 4 December, 05

Emergence of plant of 3rd sowing date – 14 December, 05

### 3.1.9 Cultural operation

Proper cultural practices were done for ensuring the normal growth of the crop. Top dressing of urea was done as per schedule and the normal cultural practices including weeding and insecticides spray were done as and when needed. There was some incidence of insect attack, which was controlled by spraying pesticide, Nuvacrone. Irrigation was given uniformly to the plots. Plant protection measures were taken to protect the matured seeds against the attack of pigeon and rat.

### 3.1.10 Green pod harvest

The border two rows at each side of the plots were not considered for analysis and discussion assuming the interference of the border effects. Three alternate rows from middle six rows of each plot were harvested to record the yield and different parameters of green pea like, plant height, number of primary branches, number of pods / plant, number of seeds / pod, weight of 100 green seeds, green pod yield, and matured seed yield. The required days of harvesting of green pod for $D_1$, $D_2$ and $D_3$ were, 50 days, 55 days and 62 days, respectively.

### 3.1.11 Matured pod harvest

The rest three of the middle six rows of the crop was harvested at maturity. Harvesting dates of the treatments $D_1$, $D_2$ and $D_3$ were 30/01/06 (at 72 days after sowing seeds), 14/02/06 (at 76 days after sowing seeds), 28/02/06 (at 80 days after seed sowing) and respectively. The harvested crop was sun-dried treatment wise. Matured seed and Weight of 100 matured seed and matured seed yield were

recorded separately. Moisture percentage of the seeds was determined after sun drying. Dry weight for both grain and straw were also recorded.

### 3.1.12 Data collection

The data on the following yield contributing characters of the crop were recorded:

a. Data at green pod stage:

i) Green pod yield

ii) Plant fresh weight

b. Data at matured pod stage:

i) Plant height of matured pod stage

ii) Number of primary branches

iii) Plant dry weight

iv) Number of pods /plant

v) Number of seeds / pod

vi) Weight of 100 green seeds

vii) Weight of 100 matured seeds

viii) Matured seed yield

### 3.1.13 Chemical analysis of soil samples

Soil samples collected before initiation of the experiment and after harvest of the crop, were analyzed for both physical and chemical properties. The analysis was done at the Soil Science Division of Bangladesh Agricultural Research Institute (BARI), Joydevpur, Gazipur. The properties studied included soil texture, pH,

(BARI), Joydevpur, Gazipur. The properties studied included soil texture, pH, organic matter, total N, available P, exchangeable K and available S. The physical and chemical properties of the initial soils have been presented in Table 2. The soil was analyzed following standard methods:

**Soil pH:** pH was measured with the help of a glass electrode pH meter using soil water suspension of 1: 2.5 as described by Jackson (1962).

**Organic carbon:** Organic carbon in soil was determined by Walkley and Black's (1934) Wet Oxidation Method. The underlying principle is to oxidize the organic carbon with an excess of 1 N $K_2Cr_2O_7$ in presence of conc. $H_2SO_4$ and to titrate the residual $K_2Cr_2O_7$ solution with 1 N $FeSO_4$ solution. To obtain the % organic matter content, the amount of organic carbon was multiplied by the Van-Bemmelen factor, 1.73.

**Total nitrogen:** Total nitrogen of soil was determined by micro Kjeldahl method. where soil was digested with 30% $H_2O_2$, and conc. $H_2SO_4$ and catalyst mixture ($K_2SO_4$:$CuSO_4.5H_2O$: Se powder in the ratio of 100:10:1). Nitrogen in the digest was estimated by distillation with 40% NaOH followed by titrations of the distillate trapped in $H_3BO_3$ with 0.01 N $H_2SO_4$ (Bremner and Mulvaney, 1982).

**Available Phosphorus:** Available P was extracted from soil by shaking with 0.5 M $NaHCO_3$ solution of pH 8.5 (Olsen *et al.* 1954). The Phosphorus in the extract was then determined by developing blue colour using $SnCl_2$ reduction of

phosphomolybdate complex. The absorbance of the molybdophosphate blue colour was measured at 660 nm wave length by spectrophotometer and available P was calculated with the help of standard curve.

**Exchangeable potassium:** Exchangeable K was determined by 1N $NH_4OAC$ (pH 7.0) extract of the soil by using flame photometer (Black, 1965).

**Available sulphur:** Available S in soil was determined by extracting the soil samples with 0.15% $CaCl_2$ solution (Page *et al.*, 1982). The S content in the extract was determined turbidimetrically and the intensity of turbid was measured by spectrophotometer at 420 nm wavelength.

### 3.1.14 Chemical analysis of plant samples

#### 3.1.14.1 Preparation of plant samples

Plant samples were collected immediately after harvest of the crop. Pods and plants were cleaned with distilled water and dried at first in the sunlight and then in an oven at $65^0$C for 48 hours. The dried samples were then ground with a grinder. The prepared samples were then put into small paper bags and kept into a dessicator till being used.

#### 3.1.14.2 Digestion of plant samples with sulphuric acid

For N determination an amount of 0.1 g plant sample (grain/straw) was taken into a 100 ml Kjeldahl flask. An amount of 1.1 g catalyst mixture ($K_2SO_4$: $CuSO_4$. $5H_2O$: Se = 100: 10: 1), 2 ml 30% $H_2O_2$ and 3 ml conc. $H_2SO_4$ were added into the

flask. The flask was swirled and allowed to stand for about 10 minutes; followed by heating at $200^0$ C. Heating was continued until the digest was clear, and colorless. After cooling, the contents were taken into a 100 ml volumetric flask and the volume was made with distilled water. Reagent blank was prepared in a similar way. This digest was used for determining the nitrogen contents in plant samples.

### 3.1.14.3 Digestion of plant samples with nitric-perchloric acid mixture

An amount of 0.5 g of plant sample was taken into a dry clean 100 ml. Kjeldahl flask and added 10 ml of di-acid mixture.

### 3.1.14.4 Determination of elements in the digest

Nitrogen content in the digest was determined by similar method as described in the soil analysis. Phosphorus content was determined following the procedure as described in the soil analysis section. Potassium concentration of the digest was determined directly by flame photometer. Sulphur concentration in the digest was estimated turbidimeterically by a spectrophotometer using 420 nm wave lengths.

### 3.1.14.5 Soil physical analysis:

**Particle-size analysis:** Particle size analysis of soil was done by Hydrometer method (Bouyoucos, 1926) and the textural class was determined by plotting the values of % sand, % silt and % clay on the USDA Triangle of the textural classes.

### 3.1.14.6 Statistical Analysis

The statistical analysis for different characters including the nutrient content and uptake were done following the ANOVA technique and the mean results in case of significant F-values were adjusted by the Duncan's Multiple Range Test (DMRT).

# Chapter IV

# RESULTS AND DISCUSSION

This chapter is arranged with the presentation of experimental results along with their possible interpretation and discussion in relation to the different sowing date, fertilizer application and also their interaction on different yield contributing character, yield and nutrients customary by pea plant and soil. The results have been presented under the following headings:

## 4.1 Yield contributing characters and yield of pea

### 4.1.1 Plant height during green pod harvesting stage

#### 4.1.1.1 Effect of sowing date on plant height

Considering the plant height of pea under the present trial a statistically significant variation was recorded among different sowing dates (Appendix I). The maximum plant height (39.86 cm) was recorded in 2nd sowing date, November 28. On the other hand the minimum plant height (36.74 cm) was recorded in sowing date December 10 which was statistically identical with the sowing date November 18 (36.80 cm). The results related to plant height were presented in Table 4. Plant height is a genetical character, and it is expected that the same variety would have similar plant height. But date of sowing is an important factor, which influenced the plant height. Different sowing date assured different environmental conditions, which was the ultimate cause in the variation of plant height.

**Table 4. Effect of different sowing date on the yield contributing character of pea**

| Sowing date | Plant height (cm) | Primary branches (No.) | Plant fresh weight (t/ha) | Plant dry weight (t/ha) | Pods/ plant (No.) | Seeds/ pod (No.) |
|---|---|---|---|---|---|---|
| November, 18 | 36.80 b | 2.07 ab | 3.28 b | 1.42 b | 6.35 b | 3.96 b |
| November, 28 | 39.86 a | 3.66 a | 3.44 a | 1.54 a | 8.49 a | 4.17 a |
| December,10 | 36.74 b | 1.69 b | 3.10 c | 1.40 b | 5.00 c | 3.84 b |
| Significance level | ** | ** | ** | ** | ** | ** |
| $LSD_{0.05}$ | 1.428 | 0.596 | 0.113 | 0.077 | 0.134 | 0.139 |

** Significant at 1% level;

In a column means having a common letter(s) do not differ significantly at 5% level of significant

### 4.1.1.2 Effect of fertilizer on plant height

A significant variation was recorded in consideration of plant height in different fertilizer application (Appendix I). The results were presented in Table 5. The maximum plant height (41.53 cm) was recorded in 90 kg N $ha^{-1}$ which was statistically significant and closely followed by 60 kg N $ha^{-1}$ (39.50 cm) and the minimum plant height (33.73 cm) was recorded in control condition where no fertilizer was used. From these results it was found that mainly nitrogenous fertilizer increased plant height as well as vegetative growth. Ahmad *et al.* (1975) reported that maximum plant height of garden pea was obtained by the application of 80 kg N $ha^{-1}$ which was similar with the findings of this experiment.

**Table 5. Effect of different doses of fertilizer on yield contributing character of pea**

| Fertilizer | Plant height at matured pod stage(cm) | Primary branches at matured pod stage(No.) | Plant fresh weight at green pod stage(t/ha) | Plant dry weight matured pod stage(t/ha) | Pods/ plant at matured pod stage(No.) | Seeds/ pod at matured pod stage(No.) |
|---|---|---|---|---|---|---|
| No fertilizer | 33.73 d | 1.25 d | 2.85 e | 1.15 e | 5.49 e | 3.17 d |
| Cowdung10 t $ha^{-1}$ | 36.06 c | 3.43 ab | 3.04 d | 1.31 d | 5.89d | 3.73 c |
| 30 kg N $ha^{-1}$ | 37.98 bc | 1.38 d | 3.17 cd | 1.43 c | 6.30 c | 4.13 b |
| 60 kg N $ha^{-1}$ | 39.50 b | 3.32 b | 3.46 b | 1.62 b | 7.71 b | 4.30 b |
| 90 kg N $ha^{-1}$ | 41.83 a | 3.62 a | 3.80 a | 1.78 a | 8.33 a | 4.87 a |
| PKS but no N | 37.68 bc | 2.00 c | 3.31 bc | 1.37 cd | 5.96 d | 3.72c |
| Significance level | ** | ** | ** | ** | ** | ** |
| $LSD_{0.05}$ | 2.019 | 0.243 | 0.160 | 0.109 | 0.189 | 0.196 |

** Significant at 1% level;

In a column means having a common letter(s) do not differ significantly at 5% level of significant

#### 4.1.1.3 Interaction effect of sowing date and fertilizer on plant height

The interaction effect between different sowing date and different fertilizers showed statistically non significant differences in consideration of plant height of pea under the present study. But the maximum plant height (43.73 cm) was recorded in sowing date November 28 with 90 kg N $ha^{-1}$ (Table 6). The minimum plant height (32.50 cm) was recorded in sowing date December 10 with control condition of fertilizer application.

### 4.1.2 Number of primary branches of matured pod stage

#### 4.1.2.1 Effect of sowing date on the number of primary branches

A statistically significant variation was found among different sowing dates in consideration the number of branches/plant under the present piece of experiment (Appendix I). The highest number of branches/plant (3.66) was recorded in sowing date November 28. On the other hand the lowest number of branches/plant (1.69) was recorded in sowing date December 10 (Table 4). Generally, the more number of branches, the more pods and thereby the higher yield.

**Table 6. Interaction effect of different sowing date and different doses of fertilizer on yield contributing character of pea**

| Sowing date | Fertilizer | Plant height (cm) | Primary branches (No.) | Plant fresh weight (t/ha) | Plant dry weight (t/ha) | Pods/ plant (No.) | Seeds/ pod (No.) |
|---|---|---|---|---|---|---|---|
| November, 18 | No fertilizer | 33.56 | 1.05 | 2.90 | 1.12 | 4.45 | 3.12 |
| | Cowdung10t/ ha | 35.84 | 2.28 | 3.05 | 1.25 | 5.98 | 3.65 |
| | 30 kg N $ha^{-1}$ | 36.45 | 2.47 | 3.14 | 1.37 | 7.52 | 4.12 |
| | 60 kg N $ha^{-1}$ | 38.17 | 2.75 | 3.45 | 1.65 | 7.74 | 4.25 |
| | 90 kg N $ha^{-1}$ | 41.53 | 3.53 | 3.89 | 1.78 | 8.38 | 4.84 |
| | PKS but no N | 35.22 | 1.95 | 3.25 | 1.32 | 6.05 | 3.75 |
| November, 28 | No fertilizer | 35.12 | 1.25 | 2.99 | 1.24 | 5.66 | 3.28 |
| | Cowdung10t/ ha | 38.27 | 2.75 | 3.22 | 1.43 | 7.07 | 3.98 |
| | 30 kg N $ha^{-1}$ | 39.95 | 2.95 | 3.38 | 1.52 | 7.66 | 4.32 |
| | 60 kg N $ha^{-1}$ | 41.81 | 3.22 | 3.68 | 1.68 | 7.95 | 4.56 |
| | 90 kg N $ha^{-1}$ | 43.73 | 3.98 | 3.92 | 1.88 | 8.55 | 5.00 |
| | PKS but no N | 40.27 | 2.95 | 3.42 | 1.48 | 6.05 | 3.86 |
| December,10 | No fertilizer | 32.50 | 1.75 | 2.65 | 1.10 | 4.35 | 3.12 |
| | Cowdung10t/ ha | 34.08 | 2.85 | 2.85 | 1.24 | 6.63 | 3.56 |
| | 30 kg N $ha^{-1}$ | 37.55 | 2.75 | 2.98 | 1.41 | 6.73 | 3.95 |
| | 60 kg N $ha^{-1}$ | 38.51 | 2.55 | 3.25 | 1.52 | 7.45 | 4.08 |
| | 90 kg N $ha^{-1}$ | 40.24 | 3.25 | 3.58 | 1.68 | 8.05 | 4.78 |
| | PKS but no N | 37.55 | 2.00 | 3.28 | 1.32 | 4.78 | 3.56 |
| Significance level | | NS | NS | NS | NS | NS | NS |
| $LSD_{0.05}$ | | -- | -- | -- | -- | -- | -- |
| CV (%) | | 5.58 | 1.90 | 5.12 | 7.77 | 4.62 | 5.15 |

In a column means having a common letter(s) do not differ significantly at 5% level of significant

#### 4.1.2.2 Effect of fertilizer on the number of primary branches

Significant statistical deviation was recorded in consideration of number of branches/plant in different fertilizer application (Appendix I). The details results were presented in Table 5. The highest number of branches/plant (3.62) was recorded in 90 kg N $ha^{-1}$ which was closely followed by cow dung 10t $ha^{-1}$(3.43) and the lowest number of branches/plant (1.25) was recorded in control treatment. Generally nitrogenous fertilizer increased vegetative growth as well as number of branches/plant. Similar results also reported by Negi (1992) and Singh *et al.* (1992) earlier.

#### 4.1.2.3 Interaction effect between sowing date and fertilizer on primary branches

Interaction effect between sowing date and different fertilizer revealed statistically a non significant difference in consideration of number of branches/plant under the present experiment. The highest number of branches/plant (3.92) was recorded in sowing date November 28 with 90 kg N $ha^{-1}$ (Table 6). The lowest number of branches/plant (1.85) was recorded in sowing date December 10 in control condition.

### 4.1.3 Fresh weight of plants in green pod stage

#### 4.1.3.1 Effect of sowing date on fresh weight of plants in green pod stage

Considering the fresh weight of plants under the present experiment a statistically significant difference was found among different sowing dates of pea (Appendix

I). The highest fresh weight of plants (3.44 t/ha) was recorded in sowing date November 28 and the lowest fresh weight of plants (3.10 t/ha) was recorded in sowing date December 10 (Table 4). Early sowing of pea ensured maximum vegetative growth which was the ultimate result of highest fresh weight of plants.

### 4.1.3.2 Effect of fertilizer on fresh weight of plants in green pod stage

A significant variation was recorded in considering the fresh weight/plant in different fertilizer application (Appendix I). The results were presented in Table 5. The highest fresh weight of plants (3.80 t/ha) was recorded in 90 kg N $ha^{-1}$ which was closely followed by 60 kg N $ha^{-1}$ (3.46 t/ha). On the other hand the lowest fresh weight of plants (2.85 t/ha) was recorded in control condition where no fertilizer was used which was closely followed (3.04 t/ha) by cowdung 10 t $ha^{-1}$. From these results it was found that mainly nitrogenous fertilizer assured highest vegetative growth and the highest fresh weight.

### 4.1.3.3 Interaction effect of sowing date and fertilizer on fresh weight of plants in green pod stage

Interaction effect between sowing date and different fertilizers demonstrated a non-significant difference in consideration of fresh weight of plant of pea under the present piece of experiment. But the highest fresh weight of plant (3.92 t/ha) was recorded in sowing date November 28 with 90 kg N $ha^{-1}$ (Table 6). The lowest fresh weight of plant (2.85 t/ha) was recorded in sowing date December 10 in control condition.

### 4.1.4 Dry weight of plants in matured pod stage

#### 4.1.4.1 Effect of sowing date on dry weight of plants in matured pod stage

A statistically significant variation was found among different sowing date in respect of the dry weight of plant (except pod) under the present trial (Appendix I). The highest dry weight of plants (1.54 t/ha) was found in sowing date November 28. On the other hand, the lowest dry weight of plants (1.40 t/ha) was recorded in sowing date December 10 (Table 4) which was statistically similar (1.42 t/ha) with sowing date November 18. Generally, highest vegetative growth ensured highest yield and thereby the highest fresh weight and finally maximum dry weight.

#### 4.1.4.2 Effect of fertilizer on dry weight of plants in matured pod stage

A significant statistical difference was recorded in respect of dry weight of plant in different fertilizer application under the present experiment (Appendix I). The details results were presented in Table 5. The highest dry weight of plants (1.78 t/ha) was recorded in 90 kg N $ha^{-1}$ which was closely followed by 60 kg N $ha^{-1}$ (1.62 t/ha) and the lowest dry weight of plants (1.15 t/ha) was recorded in control condition which was closely followed by cowdung 10 t/ha.

#### 4.1.4.3 Interaction effect of sowing date and fertilizer on dry weight of plants in matured pod stage

Interaction effect between sowing date and different fertilizer doses, having non-significant differences in consideration of dry weight of plant under the present

piece of experiment. The highest dry weight of plants (1.88 t/ha) was recorded in sowing date November 28 with 90 kg N $ha^{-1}$ (Table 6). The lowest dry weight of plants (1.10 t/ha) was recorded in sowing date December 10 with control condition of fertilizer.

### 4.1.5 Number of pods/plant in green pod stage

#### 4.1.5.1 Effect of sowing date on the number of pods/plant in green pod stage

Number of pods/plant under the present piece of experiment showed a statistically significant variation among different sowing dates (Appendix I). The highest number of pods/plant (8.49) was recorded in sowing date November 28 and the lowest number of pods/plant (5.00) was recorded in sowing date December 10 (Table 4).

#### 4.1.5.2 Effect of fertilizer on the pods/plant in green pod stage

A significant variation was recorded in consideration of number of pods/plant in different fertilizer application (Appendix I). The results were presented in Table 5. The highest number of pods/plant (8.33) was recorded in 90 kg N $ha^{-1}$ which was closely followed by 60 kg N $ha^{-1}$ (7.71). The lowest number of pods/plant (5.49) was recorded in control condition where no fertilizer was applied. From this result it concluded that that higher amount of N application is necessary not only for vegetative growth but also for pod formation in pea. Similar result also reported earlier by Vijai *et al.* (1992) the result also very close to the findings of Naik

(1989) who reported that the number of pods/plant increased with increasing levels of nitrogenous fertilizer in peas.

### 4.1.5.3 Interaction effect of sowing date and fertilizer on pods/plant in green pod stage

The interaction effect between sowing date and different fertilizer showed statistically non-significant effects in respect of number of pods/plant of pea under the present piece of experiment. But the highest number of pods/plant (8.55) was recorded in sowing date November 28 with 90 kg N $ha^{-1}$ (Table 6). The lowest number of pods/plant (4.35) was recorded in sowing date December 10 with no fertilizer application.

### 4.1.6 Number of seeds/pod on green pod stage

### 4.1.6.1 Effect of sowing date on number of seeds/pod in green pod stage

A statistically significant variation was recorded among different sowing dates in consideration the number of seeds/pod under the present trial (Appendix I). The highest number of seeds/pod (4.17) was found in sowing date November 28. On the other hand the lowest number of seeds/pod (3.84) was recorded in sowing date December 10 which was statistically significant with November 18 (3.96). The details results presented in Table 4. The more vegetative growth also ensured more reproductive growth as well as maximum number of seeds/pod.

#### 4.1.6.2 Effect of fertilizer on number of seeds/pod in green pod stage

A significant statistical variation was recorded in consideration of number of seeds/pod in different fertilizer application (Appendix I). The details results were presented in Table 5. The highest number of seeds/pod (4.87) was recorded in 90 kg N $ha^{-1}$ followed by 60 kg N t $ha^{-1}$ (4.30) and 30 kg N $ha^{-1}$ (4.13) and the lowest number of seeds/pod (3.17) was recorded in control condition. Bhopal and Singh (1990) concluded that seeds per pod increased significantly with the increase in the rates of nitrogenous fertilizer.

#### 4.1.6.3 Interaction effect of sowing date and fertilizer on number of seeds/pod in green pod stage

Interaction effect between sowing date and different fertilizer having a statistically non-significant difference in consideration of number of seeds/pod under the present piece of experiment. The highest number of seeds/pod (5.00) was recorded in sowing date November 28 with 90 kg N $ha^{-1}$ (Table 6). The lowest number of seeds/pod (3.12) was recorded in sowing date December 10 and November 18 with control condition where no fertilizer was applied.

### 4.1.7 Weight of 100 green pods

#### 4.1.7.1 Effect of sowing date on the weight of 100 green pods

Considering the weight of 100 green pods under the present trial a statistically non significant variation was recorded among different sowing dates of pea (Appendix II). The highest weight of 100 green pods (45.58 g) was recorded in sowing date

November 28 and the lowest weight of 100 green pods (44.45 g) was recorded in sowing date December 10 (Table 7). Early sowing of pea ensured maximum vegetative growth, which ultimately resulted in the highest weight of 100 green pods.

**Table 7. Effect of different sowing date on yield contributing character and yield of pea**

| Sowing date | Weight of 100 green pod (g) | Weight of 100 green seeds (g) | Total dry matter of plant (g) | Green pod yield (t/ha) | Matured seed yield (t/ha) |
|---|---|---|---|---|---|
| November, 18 | 44.99 | 35.17 | 64.34 b | 6.15 b | 1.53 b |
| November, 28 | 45.58 | 35.37 | 67.03 a | 7.25 a | 1.68 a |
| December,10 | 44.45 | 34.39 | 61.97 c | 6.15 b | 1.37 c |
| Significance level | NS | NS | ** | * | ** |
| $LSD_{0.05}$ | -- | -- | 1.747 | 0.014 | 0.061 |

** Significant at 1% level; * Significant at 5% level;

In a column means having a common letter(s) do not differ significantly at 5% level of significant

### 4.1.7.2 Effect fertilizer on the weight of 100 green pods

No significant variation was recorded in respect of the weight of 100 green pods in different fertilizer application (Appendix II). The results were presented in Table 8. The highest weight of 100 green pods (46.26 g) was recorded in 90 kg N $ha^{-1}$ and the lowest weight of 100 green pods (43.42 g) was recorded in control condition where no fertilizer was used. Bhopal and Singh (1990) conducted an experiment with the semi dwarf garden pea cv. Lincoln, received N at the rate of 0, 20, 40 and 60 kg/ha. They concluded that the mean green pod yield increased with increasing N rates up to 40 kg/ha and then decreased at 60 kg/ha. Vigorous vegetative growth was attributed at the highest N rates. Singh *et al.*, (1992) also conducted a field trial with field pea cv. Rachna, given 0-30 kg N and 0-25 kg $P_2O_5$/ha. Seed yield increased with up to 30 kg N and 50 kg $P_2O_5$/ha.

**Table 8. Effect of different doses of fertilizer on yield contributing character and yield of pea**

| Fertilizer | Weight of 100 green pod (g) | Weight of 100 matured seeds (g) | Total dry matter of plant (g) | Green pod yield (t/ha) | Matured seed yield (t/ha) |
|---|---|---|---|---|---|
| No fertilizer | 43.42 | 33.52 | 51.07 e | 4.79 e | 1.05 e |
| Cowdung 10 t/ha | 44.48 | 34.72 | 60.00 d | 5.93 d | 1.32 d |
| 30 kg N $ha^{-1}$ | 45.13 | 35.09 | 65.52 c | 6.18 c | 1.48 c |
| 60 kg N $ha^{-1}$ | 45.58 | 35.61 | 71.87 b | 6.75 b | 1.77 b |
| 90 kg N $ha^{-1}$ | 46.26 | 36.07 | 75.97 a | 7.64 a | 2.02 a |
| PKS but No N | 45.18 | 34.84 | 62.25 d | 6.12 c | 1.52 c |
| Significance level | NS | NS | ** | ** | ** |
| $LSD_{0.05}$ | -- | -- | 2.471 | 0.105 | 0.086 |

** Significant at 1% level;

In a column means having a common letter(s) do not differ significantly at 5% level of significance

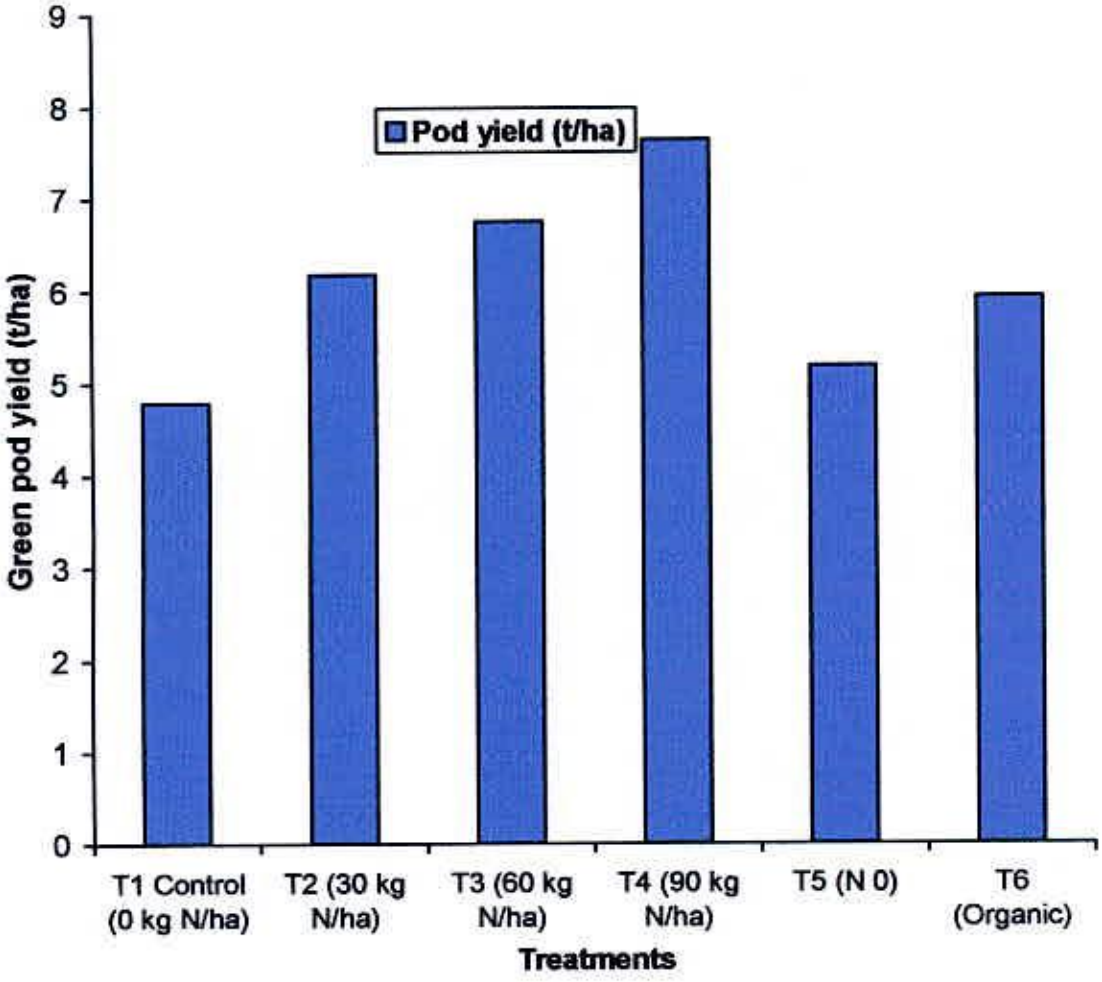



**Fig.2 Effect of differnet doses of fertilizer on green pod yield (t/ha)**

$T_1$ = Control

$T_2$ = 30 kg N/ha

$T_3$ = 60 kg N/ha

$T_4$ = 90 kg N/ha

$T_5$ = All fertilizer except N

$T_6$ = Organic

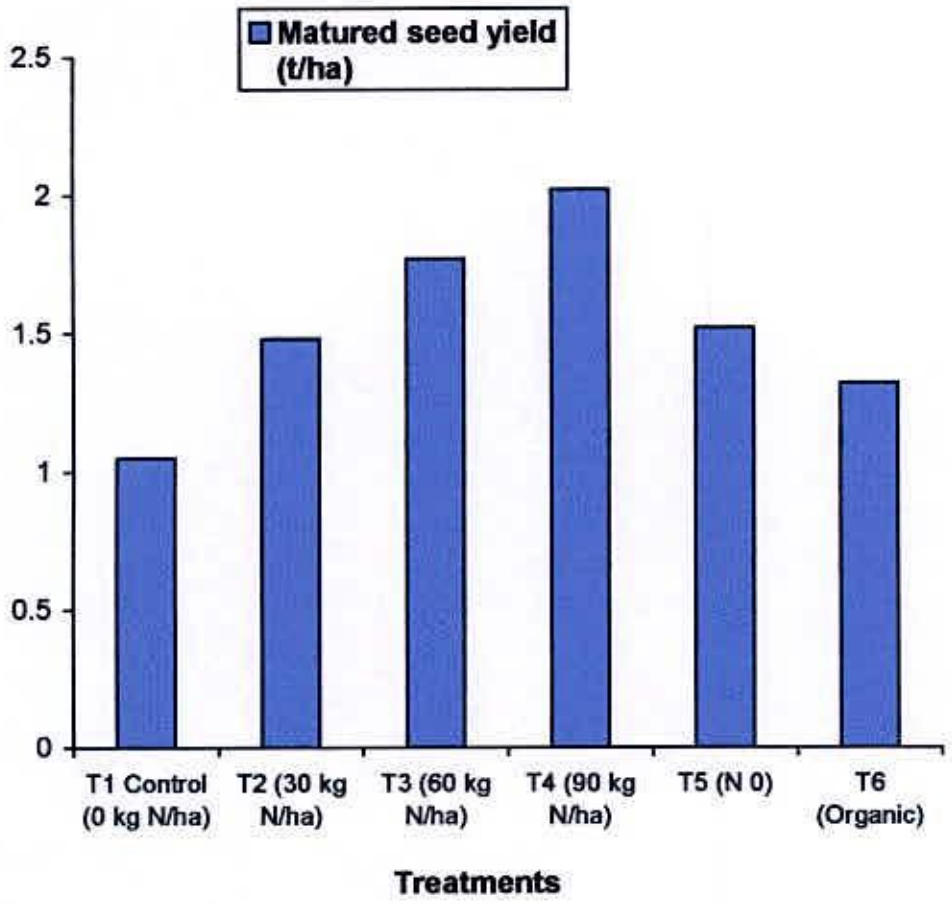



**Fig. 3 Effect of differnet doses of fertilizer on matured seed yield (t/ha)**

$T_1$ = Control

$T_2$ = 30 kg N/ha

$T_3$ = 60 kg N/ha

$T_4$ = 90 kg N/ha

$T_5$ = All fertilizer except N

$T_6$ = Organic

### 4.1.7.3 Interaction effect of sowing date and fertilizer on the weight of 100 green pods

Interaction effect between sowing date and different fertilizer demonstrated a non-significant difference in consideration of weight of 100 green pod of pea under the present piece of experiment. But the highest weight of 100 green pods (46.92 g) was recorded in sowing date November 28 with 90 kg N $ha^{-1}$ (Table 9). The lowest weight of 100 green pods (43.05 g) was recorded in sowing date December 10 with no fertilizer application (control condition).

**Table 9. Interaction effect of different sowing date and different doses of fertilizer on yield contributing character and yield of pea**

| Sowing date | Fertilizer | Weight of 100 green pod (g) | Weight of 100 matured seeds (g) | Total dry matter (g) | Green pod yield (t/ha) | Matured seed yield (t/ha) |
|---|---|---|---|---|---|---|
| November, 18 | No fertilizer | 43.15 | 33.55 | 50.52 | 4.05 h | 1.04 i |
| | Cowdung 10t $ha^{-1}$ | 44.50 | 34.27 | 60.43 | 5.95fg | 1.25 gh |
| | 30 kg N $ha^{-1}$ | 45.27 | 35.80 | 66.54 | 6.27de | 1.55 de |
| | 60 kg N $ha^{-1}$ | 45.63 | 35.88 | 71.56 | 6.45cd | 1.75 bc |
| | 90 kg N $ha^{-1}$ | 46.05 | 36.45 | 74.53 | 6.95ab | 2.05 a |
| | PKS but no N | 45.37 | 35.07 | 62.51 | 6.75ef | 1.45 ef |
| November, 28 | No fertilizer | 44.07 | 34.00 | 52.56 | 4.25 h | 1.10 hi |
| | Cowdung 10t $ha^{-1}$ | 44.90 | 34.83 | 63.56 | 6.05 f | 1.53 de |
| | 30 kg N $ha^{-1}$ | 45.60 | 35.37 | 68.47 | 6.92de | 1.65 cd |
| | 60 kg N $ha^{-1}$ | 46.05 | 36.00 | 73.56 | 7.03bc | 1.88 b |
| | 90 kg N $ha^{-1}$ | 46.92 | 36.55 | 79.82 | 7.83 a | 2.15 a |
| | PKS but no N | 45.95 | 35.45 | 64.23 | 6.15ef | 1.75 bc |
| December,10 | No fertilizer | 43.05 | 33.00 | 50.13 | 4.04 d | 1.02 i |
| | Cowdung 10t $ha^{-1}$ | 44.03 | 35.05 | 56.02 | 5.11 g | 1.17 hi |
| | 30 kg N $ha^{-1}$ | 44.52 | 34.10 | 61.54 | 5.55fg | 1.25 gh |
| | 60 kg N $ha^{-1}$ | 45.05 | 34.95 | 70.51 | 6.00de | 1.68 cd |
| | 90 kg N $ha^{-1}$ | 45.82 | 35.22 | 73.57 | 6.25cd | 1.75 bc |
| | PKS but no N | 44.22 | 34.00 | 60.02 | 5.15 f | |
| Significance level | | NS | NS | NS | ** | ** |
| $LSD_{0.05}$ | | -- | -- | -- | 0.182 | 0.148 |
| CV (%) | | 5.56 | 6.65 | 4.00 | 2.01 | 5.94 |

** Significant at 1% level;
In a column means having a common letter(s) do not differ significantly at 5% level of significant.

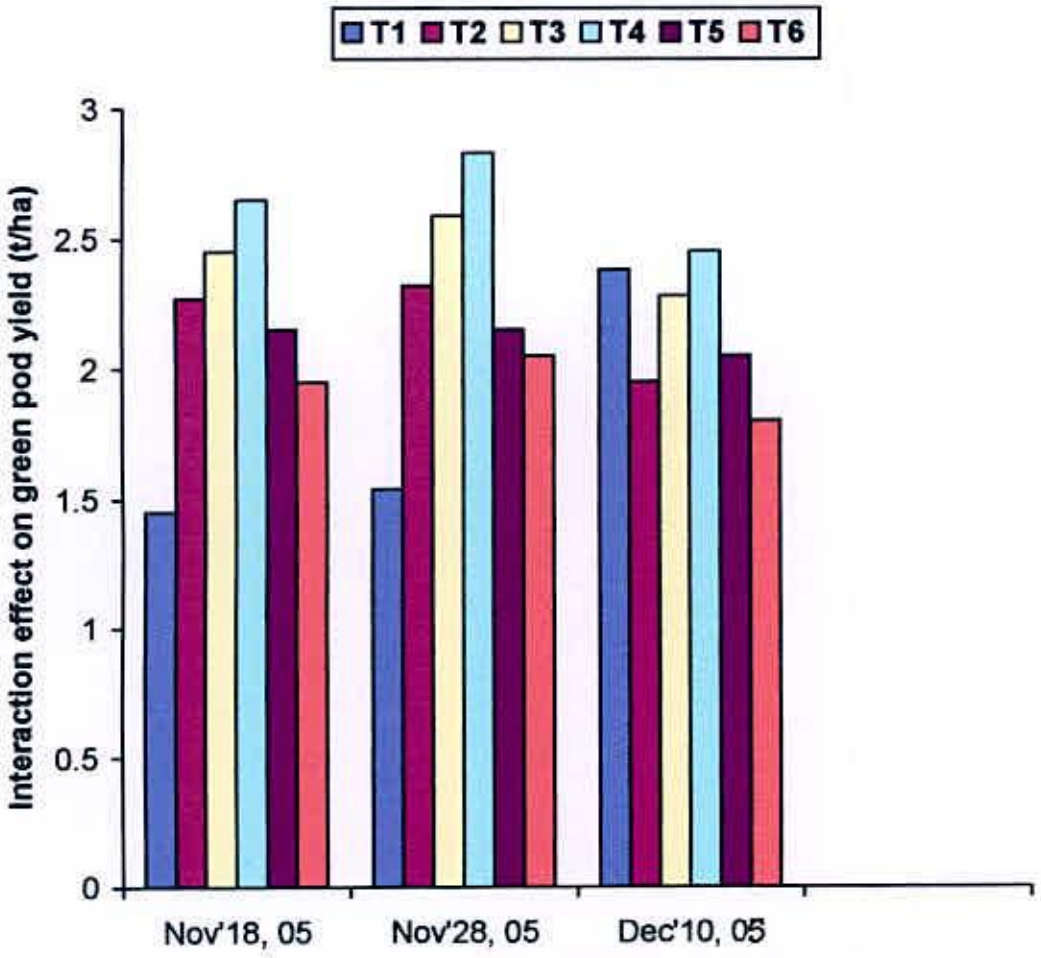



**Fig. 4 Interaction effect of different sowing date and different doses of fertilizer on yield contributing character and yield of Pea**

| | |
|---|---|
| $T_1$ = Control | $T_4$ = 90 kg N/ha |
| $T_2$ = 30 kg N/ha | $T_5$ = All fertilizer except N |
| $T_3$ = 60 kg N/ha | $T_6$ = Organic |

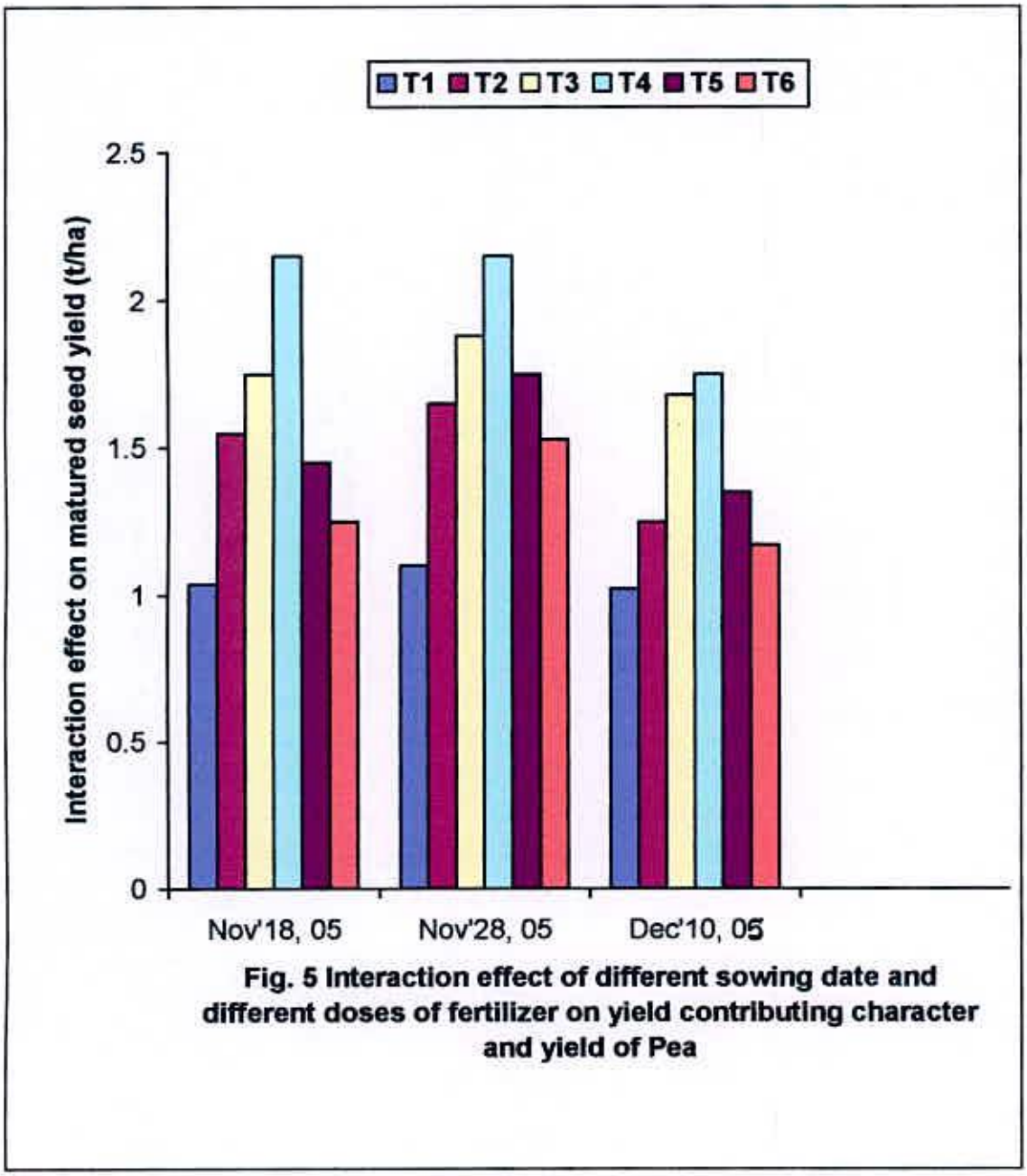



**Fig. 5 Interaction effect of different sowing date and different doses of fertilizer on yield contributing character and yield of Pea**

$T_1$ = Control $T_4$ = 90 kg N/ha

$T_2$ = 30 kg N/ha $T_5$ = All fertilizer except N

$T_3$ = 60 kg N/ha $T_6$ = Organic

### 4.1.8 Weight of 100 matured pods

#### 4.1.8.1 Effect of sowing date on the weight of 100 matured pod

The weight of 100 matured pods under the present piece of experiment showed a statistically non-significant variation among different sowing dates of pea (Appendix II). The maximum weight of 100 matured pods (35.37 g) was recorded in sowing date November 28. The minimum weight of 100 matured pods (34.39 g) was recorded in sowing date December 10 (Table 7).

#### 4.1.8.2 Effect of fertilizer on the weight of 100 matured pod

No significant variation was recorded in considering the weight of 100 matured pods in different fertilizer application (Appendix II). The results were presented in Table 5. The highest weight of 100 matured pods (36.07 g) was recorded in 90 kg N $ha^{-1}$. On the other hand the lowest weight of 100 matured pods (33.52 g) was recorded in control condition where no fertilizer was used.

#### 4.1.8.3 Interaction effect of sowing date and fertilizer on the weight of 100 matured pods

Interaction effect between sowing date and different fertilizer showed a non-significant difference in consideration of weight of 100 matured pods of pea under the present trial. But the highest weight of 100 matured pods (36.55 g) was recorded in sowing date November 28 with 90 kg N $ha^{-1}$ (Table 9). The lowest weight of 100 matured pods (33.00 g) was recorded in sowing date December 10 with no fertilizer application.

### 4.1.9 Total dry matter /plant

#### 4.1.9.1 Effect of sowing date on total dry matter / plant

Considering the total dry matter/plant of pea under the present trial a statistically significant variation was recorded among different sowing dates (Appendix II). The highest total dry matter / plant (67.03 g) was recorded in sowing date November 28. On the other hand the lowest total dry matter /plant (61.97 g) was recorded in sowing date December 10. The results were presented in (Table 4). Early sowing assured highest vegetative growth and the ultimately resulted in the highest total dry matter.

#### 4.1.9.2 Effect of fertilizer on total dry matter / plant

A significant variation was recorded in consideration of total dry matter/plant in different fertilizer application (Appendix II). The results were presented in Table 4. The highest total dry matter/plant (75.97 g) was recorded in 90 kg N $ha^{-1}$ which was closely followed by 60 kg N $ha^{-1}$ (71.87 g). On the other hand the lowest total dry matter/plant (51.07) was recorded in control condition where no fertilizer was used. Deschamps and Wery (1989) also concluded that N application increase dry mater in peas.

#### 4.1.9.3 Interaction effect of sowing date and fertilizer on total dry matter/ plant

There was no significant interaction effect between sowing date and different fertilizer in consideration of total dry matter/plant under the present piece of

experiment. The highest total dry matter (79.82 g) was recorded in sowing date November 28 with 90 kg N $ha^{-1}$ (Table 9) and the lowest total dry matter/plant (50.13 g) was recorded in sowing date December 10 with control condition.

### 4.1.10 Green pod yield

#### 4.1.10.1Effect of sowing date on green pod yield

Under the consideration of green pod yield of pea under the present piece of experiment a statistically significant variation was found among different sowing dates (Appendix II). The maximum green pod yield (7.25 t $ha^{-1}$) was recorded on sowing date November 28. On the other hand the minimum green pod yield (6.15t $ha^{-1}$) was recorded in sowing date December 10 and November 18. The results related to green pod yield were presented in Table 7. Early sowing enhanced the vegetative growth which ensured the highest green pod yield.

#### 4.1.10.2 Effect of fertilizer on green pod yield

A significant variation was recorded in consideration of green pod yield in different fertilizer application (Appendix II). The results were presented in Table 8. The maximum green pod yield (7.64 t $ha^{-1}$) was recorded in 90 kg N $ha^{-1}$ which was closely followed by 60 kg N $ha^{-1}$ (6.75 t $ha^{-1}$) and the minimum green pod yield (4.79 t $ha^{-1}$) was recorded in control condition where no fertilizer was used which was closely followed by PKS but no N condition. From these results it was found that mainly nitrogenous fertilizer increased vegetative growth as well as

green pod yield. Naik (1989) reported that green pod yield increased significantly with the increase in the dose of nitrogenous fertilizer. Bhopal and Singh (1990) also concluded that the same results.

#### 4.1.10.3 Interaction effect of sowing date and fertilizer on green pod yield

The interaction effect between sowing date and different fertilizer showed statistically significant differences in consideration of green pod yield of pea under the present trail. The maximum green pod yield (7.83t $ha^{-1}$) was recorded in sowing date November 28 with 90 kg N $ha^{-1}$ (Table 9). The minimum green pod yield (4.04t $ha^{-1}$) was recorded in sowing date December 10 with control condition of fertilizer application.

### 4.1.11 Matured seed yield

#### 4.1.11.1 Effect of sowing date on matured seed yield

Under the consideration of matured seed yield under the present piece of experiment a statistically significant difference was recorded among different sowing dates (Appendix II). The maximum matured seed yield (1.68 t/ha) was recorded in sowing date November 28 and the minimum green seed yield (1.37 t/ha) was recorded in sowing date December 10. Late sowing reduced the vegetative growth and the ultimate results of the minimum yield of matured seed.

#### 4.1.11.2 Effect of fertilizer on matured seed yield

A significant variation was recorded in respect of matured seed yield in different fertilizer application (Appendix II). The results were presented in Table 8. The maximum matured seed yield (2.02 t $ha^{-1}$) was recorded in 90 kg N $ha^{-1}$ which was closely followed by 60 kg N $ha^{-1}$ (1.77 t $ha^{-1}$). The minimum matured seed yield (1.05t $ha^{-1}$) was recorded in control condition where no fertilizer was used which was closely followed by cow dung 10 t $ha^{-1}$ (1.32 t $ha^{-1}$). From these results it was found that mainly nitrogenous fertilizer increased vegetative growth and ultimately matured pod yield. Rino *et al.* (1973) reported that the yield of peas was in increased markedly by higher doses of N application.

#### 4.1.11.3 Interaction effect of sowing date and fertilizer on Matured seed yield

Interaction effect between sowing date and different fertilizer showed statistically significant differences in respect of matured seed yield under the present piece of experiment. The maximum matured seed yield (2.15 t/ha) was recorded in sowing date November 28 with 90 kg N $ha^{-1}$ (Table 9). The minimum matured pod yield (1.02 t $ha^{-1}$) was recorded in sowing date December 10 with control condition of fertilizer application.

## 4.2 Nutrients customary in pea plant

### 4.2.1 Nitrogen

#### 4.2.1.1 Effect of sowing date on the N content of above ground biomass of pea

The nitrogen content by plant of pea under the present piece of experiment a statistically non-significant variation was recorded among different sowing dates (Appendix III). But the maximum nitrogen content by plant (2.47%) was recorded in sowing date November 28. On the other hand the minimum N content (2.45%) was recorded in sowing date December 10 and November 18 (Table 10 and Fig 7).

**Table 10. Effect of different sowing date on N, P, K and S content of above ground biomass at harvest stage**

| Sowing date | Nutrients content in plant | | | |
|---|---|---|---|---|
| | N (%) | P (%) | K (%) | S (%) |
| November, 18 | 2.45 | 0.294 | 1.22 | 0.161 |
| November, 28 | 2.47 | 0.273 | 1.20 | 0.160 |
| December, 10 | 2.45 | 0.289 | 1.24 | 0.168 |
| Significance level | NS | NS | NS | NS |
| $LSD_{0.05}$ | -- | -- | -- | -- |

** Significant at 1% level;
In a column means having a common letter(s) do not differ significantly at 5% level of significance.

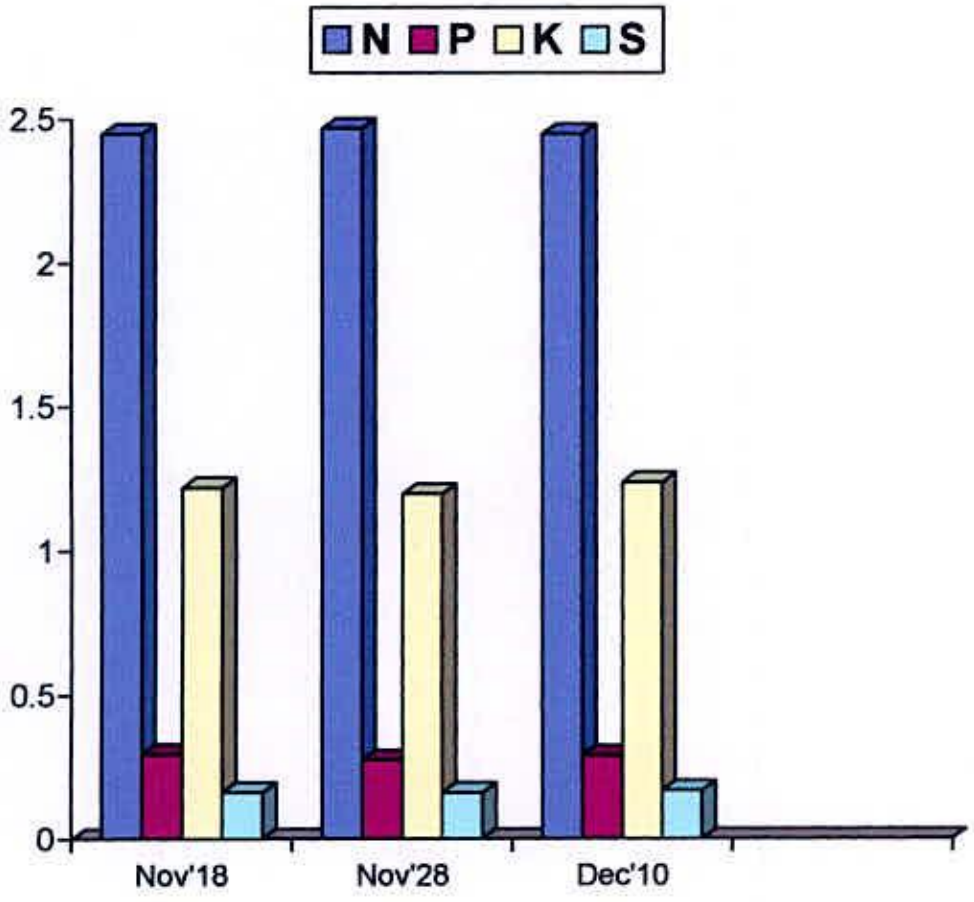



**Fig.6 N, P, K and S uptake by plants on different treatments**

#### 4.2.1.2 Effect of fertilizer on N content in pea plant

A statistically significant variation was recorded in respect of N content in plant in different fertilizer application (Appendix III). The maximum N content by plant (3.08%) was recorded in 90 kg N $ha^{-1}$ and the minimum N content in plant (2.10%) was recorded in control condition where no fertilizer was used (Table 11 and Fig 8). Makasheva (1983) reported that N content of plant biomass of field pea varied in the range of 2.5 to 3.5%, which was similar with the findings of this experiment.

**Table11. Effect of different doses of nitrogenous fertilizer on N, P, K and S content in plant after harvest of garden pea**

| Fertilizer | Nutrients content in plant | | | |
|---|---|---|---|---|
| | N (%) | P %) | K (%) | S (%) |
| No fertilizer | 2.10 c | 0.191 d | 1.09 c | 0.117 d |
| Cow dung 10 t $ha^{-1}$ | 2.20 d | 0.308 b | 1.27 b | 0.177 b |
| 30 kg N $ha^{-1}$ | 2.24 d | 0.253 c | 1.12 c | 0.146 c |
| 60 kg N $ha^{-1}$ | 2.49 c | 0.248 c | 1.13 c | 0.147 c |
| 90 kg N $ha^{-1}$ | 3.08 a | 0.249 c | 1.14 c | 0.142 c |
| PKS but No N | 2.62 b | 0.463 a | 1.56 a | 0.250 a |
| Significance level | ** | ** | ** | ** |
| $LSD_{0.05}$ | 0.105 | 0.030 | 0.086 | 0.010 |

** Significant at 1% level;

In a column means having a common letter(s) do not differ significantly at 5% level of significant

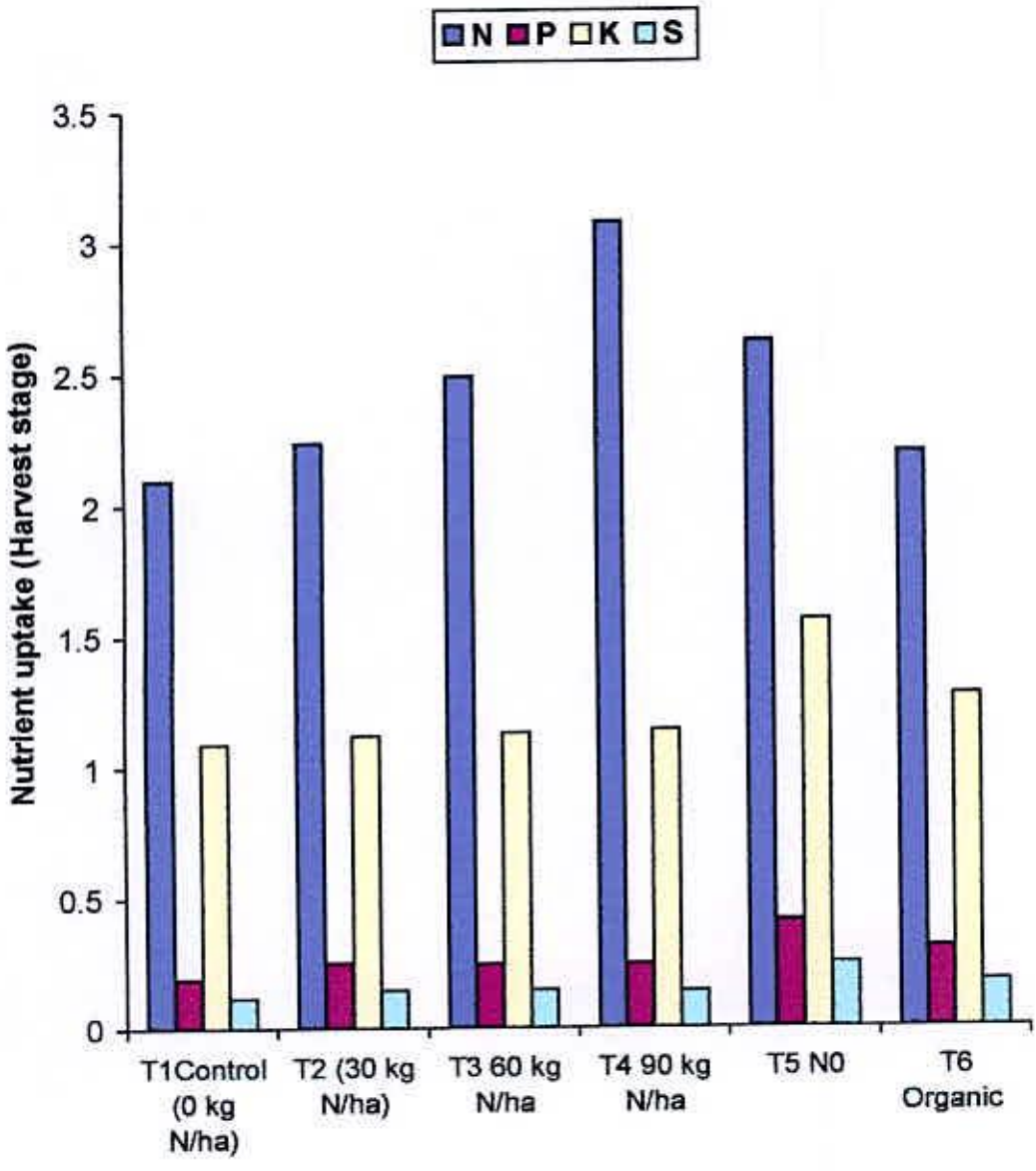



**Fig. 7 Effect of different doses of N fertilizer on N, P, K and S uptake by plant after harvest of Pea**

$T_1$ = Control

$T_2$ = 30 kg N/ha

$T_3$ = 60 kg N/ha

$T_4$ = 90 kg N/ha

$T_5$ = All fertilizer except N

$T_6$ = Organic

#### 4.2.1.3 Interaction effect of sowing date and fertilizer on the N content in plant

The interaction effect between sowing date and different fertilizer showed statistically non-significant differences in consideration of N content in plant of pea under the present trail. But the maximum N content in plant (3.10%) was recorded in sowing date November 28 with 90 kg N $ha^{-1}$ (Table 12). The minimum N content in plant (2.08%) was recorded at sowing date November 18 with control condition of fertilizer application.

**Table 12. Interaction effect of different doses of sowing date and different doses of nitrogenous fertilizer on N, P, K and S content of plant after harvest of garden pea**

| Sowing date | Fertilizer | Nutrients content in plant | | | |
|---|---|---|---|---|---|
| | | N (%) | P (%) | K (%) | S (%) |
| November, 18 | No fertilizer | 2.08 | 0.237 defg | 1.17 | 0.120 |
| | Cow dung 10 t/ha | 2.20 | 0.323 bc | 1.25 | 0.180 |
| | 30 kg N $ha^{-1}$ | 2.23 | 0.267 cde | 1.09 | 0.147 |
| | 60 kg N $ha^{-1}$ | 2.55 | 0.290 cd | 1.12 | 0.140 |
| | 90 kg N $ha^{-1}$ | 3.08 | 0.190 gh | 1.14 | 0.147 |
| | PKS but no N | 2.53 | 0.457 a | 1.56 | 0.230 |
| November, 28 | No fertilizer | 2.10 | 0.173 h | 1.01 | 0.110 |
| | Cowdung 10 t/ ha | 2.18 | 0.280 cd | 1.28 | 0.170 |
| | 30 kg N $ha^{-1}$ | 2.22 | 0.257 def | 1.10 | 0.140 |
| | 60 kg N $ha^{-1}$ | 2.59 | 0.243 defg | 1.15 | 0.160 |
| | 90 kg N $ha^{-1}$ | 3.10 | 0.200 fgh | 1.13 | 0.130 |
| | PKS but no N | 2.60 | 0.483 a | 1.52 | 0.250 |
| December,10 | No fertilizer | 2.11 | 0.163 h | 1.08 | 0.121 |
| | Cowdung 10 t/ ha | 2.22 | 0.320 bc | 1.28 | 0.180 |
| | 30 kg N $ha^{-1}$ | 2.28 | 0.237 defg | 1.16 | 0.152 |
| | 60 kg N $ha^{-1}$ | 2.33 | 0.210 efgh | 1.12 | 0.141 |
| | 90 kg N $ha^{-1}$ | 3.07 | 0.357 b | 1.17 | 0.152 |
| | PKS but no N | 2.71 | 0.450 a | 1.61 | 0.274 |
| Significance level | | NS | ** | NS | NS |
| $LSD_{0.05}$ | | -- | 0.525 | -- | -- |
| CV (%) | | 4.53 | 11.08 | 7.43 | 12.77 |

** Significant at 1% level; * Significant at 5% level;
In a column means having a common letter(s) do not differ significantly at 5% level of significance.

### 4.2.2 Phosphorus

#### 4.2.2.1 Effect of sowing date on the P content of plant

There was no statistically significant difference in phosphorus (P) content in plant of pea under the present trial among different sowing dates (Appendix III). But the maximum P content in plant (0.294 %) was recorded at sowing date November 18 and the minimum P content in plant (0.289 %) was recorded at sowing date December 10 (Table 10 and Fig 7).

#### 4.2.2.2 Effect of fertilizer on the P content of plant

A statistically significant difference was recorded in consideration of P content of plant in different fertilizer application (Appendix III). The results were presented in Table 11 and Fig 8. The maximum P content in plant (0.463 %) was recorded in PKS fertilizer application and the minimum P content in plant (0.191 %) was recorded in control condition where no fertilizer was used.

#### 4.2.2.3 Interaction effect of sowing date and fertilizer on P content of plant

There were a significant interaction effect between sowing date and different fertilizer in consideration of P content in plant of pea. The maximum P content in plant (0.483 %) was recorded at sowing date November 28 with PKS fertilizer application (Table 12). The minimum P content in plant (0. 163%) was recorded at sowing date December 10 with control condition of fertilizer application.

### 4.2.3 Potassium

#### 4.2.3.1 Effect of sowing date on K content of plant

There was no statistically significant difference in potassium (K) content in plant of pea under the present trial among different sowing dates (Appendix III). But the maximum potassium content in plant (1.24 %) was recorded at sowing date December 10 and the minimum potassium content in plant (1.20 %) was recorded at sowing date November 28 (Table 10 and Fig 7).

#### 4.2.3.2 Effect of fertilizer on K content of plant

Statistically significant variation was recorded in consideration of K content of plant at different fertilizer application (Appendix III). The results were presented in Table 11 and Fig 8. The maximum K content in plant (1.56 %) was recorded in PKS fertilizer application and the minimum K content in plant (1.09 %) was recorded in control condition of fertilizer application.

#### 4.2.3.3 Interaction effect of sowing date and fertilizer on K content of plant

There was no significant interaction effect between sowing date and different fertilizer in consideration of K content in plant of pea. The maximum K content in plant (1.61 %) was recorded at sowing date December 10 with PKS fertilizer application (Table 12). The minimum K content in plant (1.08 %) was recorded at sowing date December 10 with control condition of fertilizer application.

### 4.2.4 Sulphur

#### 4.2.4.1 Effect of sowing date on S content of plant

The sulphur (S) content in plant was recorded statistically non-significant variation among different sowing dates (Appendix III). But the maximum S content in plant (0.168%) was recorded at sowing date December 10 and the minimum S content (0.160%) was recorded at sowing date November 28. The results were presented in Table 10 and Fig 7.

#### 4.2.4.2 Effect of fertilizer on S content of plant

A statistically significant variation was recorded in consideration of S content of plant in different fertilizer application (Appendix III). The results related these were presented in Table 11 and Fig 8. The maximum S content of plant (0.250%) was recorded in PKS fertilizer application and the minimum S content of plant (0.117%) was recorded in control condition where no fertilizer was used.

#### 4.2.4.3 Interaction effect of sowing date and fertilizer on S content of plant

The interaction effect between sowing date and different fertilizer showed statistically non-significant differences in consideration of S content of. But the maximum S content in plant (0.274%) was recorded at sowing date December 10 with PKS fertilizer application (Table 12). The minimum S content in plant (0.110%) was recorded at sowing date November 18 with control condition of fertilizer application.

**Table 13. Effect of different treatments on the nutrient uptake by above ground biomass**

| Treatment | Nitrogen uptake | | | Phosphorous uptake | | | Potassium uptake | | | Sulphur uptake | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | By Biomass (kg ha$^{-1}$) | By seed (kg ha$^{-1}$) | Total (kg ha$^{-1}$) | By Biomass (kg ha$^{-1}$) | By Seed (kg ha$^{-1}$) | Total (kg ha$^{-1}$) | By Biomass (kg ha$^{-1}$) | By Seed (kg ha$^{-1}$) | Total (kg ha$^{-1}$) | By Biomass (kg ha$^{-1}$) | By Seed (kg ha$^{-1}$) | Total (kg ha$^{-1}$) |
| $T_1$ | 24.15 | 22.05 | 46.2 | 2.19 | 2.00 | 4.19 | 12.53 | 11.45 | 23.97 | 1.31 | 1.23 | 2.57 |
| $T_2$ | 32.03 | 33.152 | 65.182 | 3.62 | 3.74 | 7.36 | 16.02 | 16.57 | 32.59 | 2.09 | 2.16 | 4.25 |
| $T_3$ | 40.338 | 44.07 | 84.41 | 4.01 | 4.38 | 8.39 | 18.31 | 20.00 | 38.31 | 2.38 | 2.60 | 4.98 |
| $T_4$ | 54.864 | 62.22 | 117.04 | 4.43 | 5.03 | 9.46 | 20.29 | 23.03 | 43.32 | 2.53 | 2.87 | 5.30 |
| $T_5$ | 35.89 | 39.82 | 75.71 | 6.34 | 7.04 | 13.38 | 21.37 | 23.71 | 45.08 | 3.43 | 3.8 | 6.81 |
| $T_6$ | 28.82 | 29.04 | 57.86 | 4.03 | 4.06 | 8.09 | 16.64 | 17.76 | 34.40 | 2.32 | 2.34 | 4.66 |

$T_1$ = control, $T_2$ = 30 kg N/ha, $T_3$ = 60 kg N/ha, $T_4$ = 90 kg N/ha, $T_5$ = PKS fertilizer, $T_6$ = Organic

**Table 14. Effect of sowing date on nutrient uptake by biomass**

| Sowing date | Nutrient uptake by biomass of pea (kg/ha) | | | |
|---|---|---|---|---|
| | N uptake | P uptake | K uptake | S uptake |
| Nov. 18 | 34.39 | 4.12 | 17.32 | 2.28 |
| Nov. 28 | 38.04 | 4.2 | 18.48 | 2.46 |
| Dec. 10 | 34.3 | 4.05 | 17.36 | 2.32 |

### 4.3. Nutrient uptake by pea plant

**Effect of sowing date and fertilizer on the Nutrient uptake by above ground biomass of pea**

The nutrient uptake by biomass of pea plant is presented in Table-13. The nutrient uptake was directly influenced by both the nutrient content and the yield of pea plant (seed and plant weight). The highest uptake of N by the biomass (54.82 kg/ha) was found in $T_4$ treatment, which was followed by $T_3$ treatment (40.34 kg/ha). The lowest uptake was $T_1$ (24.15 kg/ha) which was followed by $T_6$ (28.82 kg/ha). The highest uptake of P by the biomass (6.34 kg/ha) was found in $T_5$ treatment, which was followed by $T_4$ treatment (4.43 kg/ha). The lowest uptake $T_1$ (2.19 kg/ha) which was followed by $T_2$ (3.62 kg/ha). The highest uptake of K by the biomass (21.37 kg/ha) was found in $T_5$ treatment, which was followed by $T_4$ treatment (20.29 kg/ha). The lowest uptake was $T_1$ (12.53 kg/ha) which was followed by $T_2$ (16.02 kg/ha). The highest uptake of S by the biomass (3.43 kg/ha) was found in $T_5$ treatment, which was followed by $T_4$ treatment (2.53 kg/ha). The lowest uptake $T_1$ (1.34 kg/ha) that was followed by $T_2$ (2.09 kg/ha). The highest uptake of N by the seed (62.22 kg/ha) was found in $T_4$ treatment, which was followed by $T_3$ treatment (44.07 kg/ha). The lowest uptake was $T_1$ (22.05 kg/ha) which was followed by $T_6$ (29.06 kg/ha). The highest uptake of P by the seed (7.04 kg/ha) was found in $T_5$ treatment, which was followed by $T_4$ treatment (5.03 kg/ha). The lowest uptake was $T_1$ (2.00 kg/ha) which was followed by $T_6$ (3.74 kg/ha). The highest uptake of K by the seed (23.71 kg/ha) was found in $T_5$

treatment, which was followed by $T_4$ treatment (23.03 kg/ha). The lowest uptake $T_1$ (11.45 kg/ha) which was followed by $T_6$ (16.57 kg/ha). The highest uptake of S by the seed (3.8 kg/ha) was found in $T_5$ treatment, which was followed by $T_4$ treatment (2.87 kg/ha). The lowest uptake $T_1$ (1.23 kg/ha) which was followed by $T_6$ (2.16 kg/ha).

The highest uptake of N was (38.04 kg/ha) on the sowing date Nov. 28 and lowest Dec. 10 (34.30 kg/ha), which was closely, followed by Nov. 18(34.79 kg/ha). The highest uptake of P was (4.20 kg/ha) on the sowing date Nov. 28 and lowest Dec. 10 (4.05 kg/ha), which was closely, followed by Nov. 18 (4.12 kg/ha). The highest uptake of K was (18.48 kg/ha) on the sowing date Nov. 28 and lowest Nov. 18 (17.32 kg/ha), which was closely, followed by Dec. 10. The highest uptake of S was (2.46 kg/ha) on the sowing date Nov. 28 and lowest was Nov. 18(2.28 kg/ha), which was closely followed by Dec. 10 (2.35 kg/ha).

### 4.4 Effect of sowing date and different doses of fertilizer on nutrient content in soil after harvest of pea

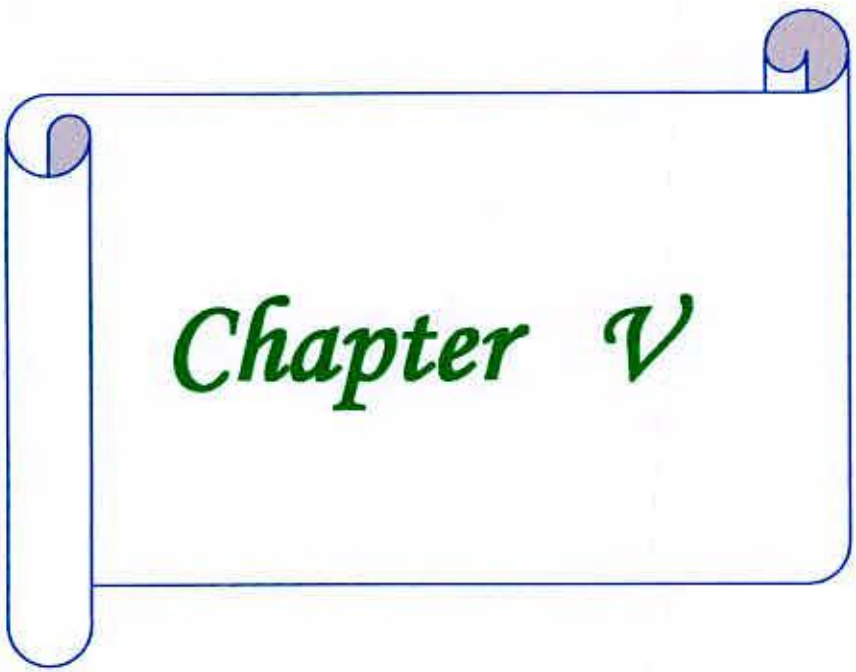
The maximum nitrogen content in soil (0.177%) was recorded in sowing date December 10 and the minimum N content in soil (0.158%) was recorded in sowing date November 18 which was statistically identical by November 18 (0.162%). The results were presented in Appendix IV. Maximum P content in soil (160.33µg/ml) was recorded in sowing date November 28 and the minimum P

content in soil (158.44µg/ml) was recorded in sowing date November 18 (Appendix IV). maximum potassium content in soil (0.190 meq/100 ml) was recorded in sowing date December 10 and the minimum potassium content in soil (0.186 meq/100ml) was recorded in sowing date November 18 (Appendix IV).

Maximum N content in soil (0.237%) was recorded in 90 kg N $ha^{-1}$ and the minimum (0.113%) was recorded in control condition where no fertilizer was used (Appendix V). Maximum P contents of soil (191.89µg/ml) were recorded in PKS fertilizer application and the minimum P content of soil (147.33µg/ml) was recorded in control condition where no fertilizer was used. The highest K absorbs by soil (0.264 meq/100 ml) was recorded in PKS fertilizer application and the lowest K content of soil (0.167 meq/100 ml) was recorded in control condition of fertilizer application. Higher S content of soil (34.42%) was recorded in PKS fertilizer application and lower S content (22.01%) was recorded in control condition where no fertilizer was used (Appendix V).

Maximum N content in soil (0.255%) was recorded in sowing date December 10 with 90 kg N $ha^{-1}$ (Appendix VI). Minimum N content of soil (0.110%) was recorded in sowing date November 18 with control condition. Maximum P content (192.00µg/ml) was recorded in sowing date December 10 with PKS fertilizer application (Appendix VI). Minimum P content of soil (142.33µg/ml) was recorded in sowing date November 18 with control condition. Maximum K content of plant (0.273 meq/100 ml) was recorded in sowing date December 10 with PKS fertilizer application (Appendix VI). Minimum K content of soil (0.150

meq/100 ml) was recorded in sowing date November 18 with control condition of fertilizer application. Maximum S content of soil (35.29%) was recorded in sowing date December 10 with PKS fertilizer application. Minimum S content of soil (0.110%) was recorded in sowing date December 10 with control condition of fertilizer application (Appendix VI).


Chapter V

# SUMMARY AND CONCLUSION

A field experiment was conducted at the Sher-e-Bangla Agricultural University farm during the period from November 18, 2005 to February 28, 2006, to find out the optimum levels of N and optimum sowing date for maximum yield of the IPSA-1, a released variety of pea.

There are 18 treatments combinations comprising of four levels of N (0, 30, 60 and 90 kg N $ha^{-1}$). A common dose of $P_2O_5$ (75 kg $ha^{-1}$), $K_2O$ (60 kg $ha^{-1}$), gypsum (10 kg $ha^{-1}$) and $ZnSO_4$ (2 kg $ha^{-1}$). Three sowing date as November 18$^{th}$ 2005, November 28$^{th}$ 2005 and December 10$^{th}$ 2006. The maximum plant height (41.53 cm) was recorded in 90 kg N $ha^{-1}$ which was closely followed by 60 kg N $ha^{-1}$ (39.50 cm) and the minimum plant height (33.73 cm) was recorded in control condition where no fertilizer was used which was closely followed (36.06 cm) by 30 kg N $ha^{-1}$. The highest number of branches/plant (4.62) was recorded in 90 kg N $ha^{-1}$ which was closely followed by cow dung 10 t $ha^{-1}$ (4.43) and 60 kg N $ha^{-1}$ (4.32) and the lowest number of branches/plant (2.25) was recorded in control condition which was closely followed (2.38) by 30 kg N $ha^{-1}$. The highest fresh weight of plants (3.80 t/ha) was recorded in 90 kg N $ha^{-1}$ which was closely followed by 60 kg N $ha^{-1}$ (3.46 t/ha). On the other hand the lowest fresh weight of plants (2.85 t/ha) was recorded in control condition where no fertilizer was used which was closely followed (3.04 t/ha) by 30 kg N $ha^{-1}$. The highest dry weight of

plants (1.78 t/ha) was recorded in 90 kg N $ha^{-1}$ which was closely followed by 60 kg N $ha^{-1}$ (1.62 t/ha) and the lowest dry weight of plants (1.15 t/ha) was recorded in control condition which was closely followed by 30 kg N $ha^{-1}$ (1.31 t/ha). The highest number of pods/plant (8.33) was recorded in 90 kg N $ha^{-1}$ which was closely followed by 60 kg N $ha^{-1}$ (8.71). The lowest number of pods/plant (5.49) was recorded in control condition where no fertilizer was applied. The highest number of seeds/pod (4.87) was recorded in 90 kg N $ha^{-1}$ which was closely followed by 30 kg N t $ha^{-1}$ (4.13) and 60 kg N $ha^{-1}$ (4.30) and the lowest number of seeds/pod (3.17) was recorded in control condition which was closely followed by cowdung 10 t $ha^{-1}$. The highest weight of 100 green pods (46.26 g) was recorded in 90 kg N $ha^{-1}$ and the lowest weight of 100 green pods (43.42 g) was recorded in control condition where no fertilizer was used. The highest weight of 100 matured pods (36.07 g) was recorded in 90 kg N $ha^{-1}$. On the other hand the lowest weight of 100 matured pods (33.52 g) was recorded in control condition where no fertilizer was used. The highest total dry matter/plant (75.97 g) was recorded in 90 kg N $ha^{-1}$ which was closely followed by 60 kg N $ha^{-1}$ (71.87 g). The maximum green pod yield (7.64 t $ha^{-1}$) was recorded in 90 kg N $ha^{-1}$ which was closely followed by 60 kg N $ha^{-1}$ (6.75 t $ha^{-1}$) and the minimum green pod yield (4.79 t $ha^{-1}$) was recorded in control condition, which was closely followed by cow dung 10 t $ha^{-1}$. The maximum matured seed yield (2.02 t $ha^{-1}$) was recorded in 90 kg N $ha^{-1}$ which was closely followed by 60 kg N $ha^{-1}$ (1.77t $ha^{-1}$). The minimum matured seed yield (1.05t $ha^{-1}$) was recorded in control condition where no fertilizer was

used which was closely followed by cowdung 10 t $ha^{-1}$ (1.32 t $ha^{-1}$). The maximum N content by plant (3.08%) was recorded in 90 kg N $ha^{-1}$ and the minimum N content by plant (2.10%) was recorded in control condition where no fertilizer was used. The maximum P content by plant (0.463%) was recorded in PKS fertilizer application and the minimum P content by plant (0.191%) was recorded in control condition.

The maximum plant height (39.86 cm) was recorded in sowing date November 28. On the other hand the minimum plant height (36.74 cm) was recorded in sowing date December 10 which was statistically identical with the sowing date November 18 (36.80 cm). The highest number of branches/plant (3.66) was found in sowing date November 28. On the other hand the lowest number of branches/plant (1.69) was recorded in sowing date December 10. The highest fresh weight of plants (3.44 t/ha) was recorded in sowing date November 28 and the lowest fresh weight of plants (3.10 t/ha) was recorded in sowing date December 10. The highest dry weight of plants (1.54 t/ha) was found in sowing date November 28. On another way the lowest dry weight 0f plants (1.40 t/ha) was recorded in sowing date December 10. The highest number of pods/plant (8.49) was recorded in sowing date November 28 and the lowest number of pods/plant (5.00) was recorded in sowing date December 10. The highest number of seeds/pod (4.17) was found in sowing date November 28. On the other hand the lowest number of seeds/pod (3.84) was recorded in sowing date December 10

which was statistically similar with November 18 (3.96). The highest weight of 100 green pods (45.58 g) was recorded in sowing date November 28 and the lowest weight of 100 green pods (44.45 g) was recorded in sowing date December 10. The highest weight of 100 matured pods (35.37 g) was recorded in sowing date November 28. The lowest weight of 100 matured pods (34.39 g) was recorded in sowing date December 10. The highest total dry matter/plant (67.03 g) was recorded in sowing date November 28. On the other hand the lowest total dry matter/plant (61.97 g) was recorded in sowing date December 10. The maximum green pod yield (7.25 t $ha^{-1}$) was recorded in sowing date November 28. On the other hand the minimum green pod yield (4.15t $ha^{-1}$) was recorded in sowing date December 10 and November 18. The maximum matured seed yield (1.68t $ha^{-1}$) was recorded in sowing date November 28 and the minimum green seed yield (1.37t $ha^{-1}$) was recorded in sowing date December 10. The maximum nitrogen content by plant (2.47%) was recorded in sowing date November 28. On the other hand the minimum N content (2.45%) was recorded in sowing date December 10 and November 18. the maximum P content by plant (0.294%) was recorded in sowing date November 18 and the minimum P content by plant (0.289%) was recorded in sowing date December 10.

The maximum plant height (43.73 cm) was recorded in sowing date November 28 with 90 kg N $ha^{-1}$. The minimum plant height (32.50 cm) was recorded in sowing date December 10 with control condition of fertilizer application. The highest number of branches/plant (4.92) was recorded in sowing date November 28 with

90 kg N $ha^{-1}$. The lowest number of branches/plant (2.85) was recorded in sowing date December 10 in control condition. The highest fresh weight of plants (3.92 t/ha) was recorded in sowing date November 28 with 90 kg N $ha^{-1}$. The lowest fresh weight of plants (2.85 t/ha) was recorded in sowing date December 10 with no fertilizer application (control condition). The highest dry weight/plant (1.88 g) was recorded in sowing date November 28 with 90 kg N $ha^{-1}$. The lowest dry weight/plant (1.10 g) was recorded in sowing date December 10 with control condition of fertilizer. The highest number of pods/plant (8.55) was recorded in sowing date November 28 with 90 kg N $ha^{-1}$. The lowest number of pods/plant (4.35) was recorded in sowing date December 10 with no fertilizer application. The highest number of seeds/pod (5.00) was recorded in sowing date November 28 with 90 kg N $ha^{-1}$. The lowest number of seeds/pod (3.12) was recorded in sowing date December 10 and November 18 with control condition. The highest weight of 100 green pods (46.92 g) was recorded in sowing date November 28 with 90 kg N $ha^{-1}$. The lowest weight of 100 green pods (43.05 g) was recorded in sowing date December 10 in control condition. The highest weight of 100 matured pods (36.55 g) was recorded in sowing date November 28 with 90 kg N $ha^{-1}$. The lowest weight of 100 matured pods (33.00 g) was recorded in sowing date December 10 with no fertilizer application. The highest total dry matter (79.82 g) was recorded in sowing date November 28 with 90 kg N $ha^{-1}$ and the lowest total dry matter/plant (50.13 g) was recorded in sowing date December 10 with control condition. The maximum green pod yield (7.83t $ha^{-1}$) was recorded in sowing date

November 28 with 90 kg N $ha^{-1}$. The minimum green pod yield (4.04t $ha^{-1}$) was recorded in sowing date December 10 in control condition of fertilizer application. The maximum matured seed yield (2.15t $ha^{-1}$) was recorded in sowing date November 28 with 90 kg N $ha^{-1}$. The minimum matured pod yield (1.02 t $ha^{-1}$) was recorded in sowing date December 10 with control condition of fertilizer application. The maximum N content by plant (3.10%) was recorded in sowing date November 28 with 90 kg N $ha^{-1}$. The minimum N content by plant (2.08%) was recorded in sowing date November 18 with control condition of fertilizer application. The maximum P content by plant (0.48%) was recorded in sowing date November 28 with PKS fertilizer application. The minimum P content by plant (0.16%) was recorded in sowing date December 10 with control condition of fertilizer application.

i) As there were no nodule formation in the roots under present study, so the recommended dose of N is 90 kg N/ha for approaching the high yield potential of pea at SAU farm soil

ii) Two sowing dates of the month of November performed better than the sowing date of December, in respect of yield and yield contributing characters. So middle of November is the optimum sowing time of this variety.

iii) The application of N, P, K, S and Zn is indispensable at SAU farm soil for successful production of pea.

This result however is generated from single trial. Further research works at different regions of the country are needed to be carried out for the confirmation of the present findings.

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# APPENDIX

**Appendix I. Analysis of variance of the data on effect of different sowing date and doses of fertilizer on yield contributing character of pea**

| Sources of variation | Degrees of freedom | Plant height (cm) | Primary branches (No.) | Plant fresh weight (g) | Plant dry weight (g) | Pods/ plant (No.) | Seeds/ pod (No.) |
|---|---|---|---|---|---|---|---|
| Replication | 2 | 0.614 | 1.572 | 0.017 | 0.007 | 0.046 | 0.001 |
| Sowing dates A) | 2 | 57.365** | 4.274** | 0.516** | 0.120** | 1.159** | 0.491** |
| Fertilizer (B) | 5 | 6.821** | 12.518** | 1.002** | 0.452** | 3.896** | 3.061** |
| Interaction (A×B) | 1 | 2.268 | 0.058 | 0.015 | 0.004 | 0.058 | 0.014 |
| Error | 34 | 4.441 | 0.775 | 0.028 | 0.013 | 0.039 | 0.042 |

** Significant at 1% level;

**Appendix II. Analysis of variance of the data on effect of different sowing date and doses of fertilizer on yield contributing character and yield of pea**

| Sources of variation | Degrees of freedom | Weight of 100 green pod (g) | Weight of 100 matured seeds (g) | Total dry matter (g) | Green pod yield (t/ha) | Green seed yield (t/ha) | Matured seed yield (t/ha) |
|---|---|---|---|---|---|---|---|
| Replication | 2 | 15.218 | 4.601 | 96.184 | 0.003 | 0.012 | 0.0001 |
| Sowing dates A) | 2 | 5.782 | 4.842 | 1155.09** | 0.053* | 0.388** | 0.424** |
| Fertilizer (B) | 5 | 8.521 | 6.900 | 7067.812** | 0.902** | 1.598** | 1.028** |
| Interaction (A×B) | 1 | 0.149 | 0.617 | 508.396 | 0.218** | 0.025 | 0.028** |
| Error | 34 | 6.265 | 5.415 | 665.209 | 0.012 | 0.020 | 0.008 |

** Significant at 1% level;

**Appendix III. Analysis of variance of the data on effect of different sowing date and doses of fertilizer on N, P, K and S uptake by plant after harvest of garden pea**

| Sources of variation | Degrees of freedom | Nutrients uptake by plant | | | |
|---|---|---|---|---|---|
| | | N (%) | P (µg/ml) | K (meq/100 ml) | S (%) |
| Replication | 2 | 0.034 | 0.0001 | 0.003 | 0.0001 |
| Sowing dates A) | 2 | 0.002 | 0.002 | 0.006 | 0.0001 |
| Fertilizer (B) | 5 | 1.186** | 0.081** | 0.291** | 0.020** |
| Interaction (A×B) | 1 | 0.018 | 0.007** | 0.005 | 0.0001 |
| Error | 34 | 0.012 | 0.001 | 0.008 | 0.0001 |

** Significant at 1% level;

**Appendix IV. Effect of different sowing date on N, P, K and S uptake by plant after harvest of garden pea**

| Sowing date | Nutrients uptake by plant | | | |
|---|---|---|---|---|
| | N (%) | P | K | S |
| November, 18 | 2.45 | 0.294 | 1.22 | 0.161 |
| November, 28 | 2.47 | 0.273 | 1.20 | 0.160 |
| December,10 | 2.45 | 0.289 | 1.24 | 0.168 |
| Significance level | NS | NS | NS | NS |
| $LSD_{0.05}$ | -- | -- | -- | -- |

**Appendix V. Effect of different doses of nitrogenous fertilizer on N, P, K and S uptake by plant after harvest of garden pea**

| Fertilizer | Nutrients uptake by plant | | | |
|---|---|---|---|---|
| | N (%) | P (µg/ml) | K (meq/100 ml) | S 9S) |
| No fertilizer | 2.10 e | 0.191 d | 1.09 c | 0.117 d |
| Cow dung 1 t $ha^{-1}$ | 2.20 d | 0.308 b | 1.27 b | 0.177 b |
| 30 kg N $ha^{-1}$ | 2.24 d | 0.253 c | 1.12 c | 0.146 c |
| 60 kg N $ha^{-1}$ | 2.49 c | 0.248 c | 1.13 c | 0.147 c |
| 90 kg N $ha^{-1}$ | 3.08 a | 0.249 c | 1.14 c | 0.142 c |
| PKS but No N | 2.62 b | 0.463 a | 1.56 a | 0.250 a |
| Significance level | ** | ** | ** | ** |
| $LSD_{0.05}$ | 0.105 | 0.030 | 0.086 | 0.010 |

** Significant at 1% level;

In a column means having a common letter(s) are not differ significantly at 5% level of significant

**Appendix VI. Interaction effect of different doses of sowing date and different doses of nitrogenous fertilizer on N, P, K and S uptake by plant after harvest of garden pea**

| Sowing date | Fertilizer | Nutrients uptake by plant | | | |
|---|---|---|---|---|---|
| | | N (%) | P (µg/ml) | K (meq/100 ml) | S (%) |
| November, 18 | No fertilizer | 2.08 | 0.237 defg | 1.17 | 0.120 |
| | Cow dung 1 t $ha^{-1}$ | 2.20 | 0.323 bc | 1.25 | 0.180 |
| | 30 kg N $ha^{-1}$ | 2.23 | 0.267 cde | 1.09 | 0.147 |
| | 60 kg N $ha^{-1}$ | 2.55 | 0.290 cd | 1.12 | 0.140 |
| | 90 kg N $ha^{-1}$ | 3.08 | 0.190 gh | 1.14 | 0.147 |
| | PKS but No N | 2.53 | 0.457 a | 1.56 | 0.230 |
| November, 28 | No fertilizer | 2.10 | 0.173 h | 1.01 | 0.110 |
| | Cow dung 1 t $ha^{-1}$ | 2.18 | 0.280 cd | 1.28 | 0.170 |
| | 30 kg N $ha^{-1}$ | 2.22 | 0.257 def | 1.10 | 0.140 |
| | 60 kg N $ha^{-1}$ | 2.59 | 0.243 defg | 1.15 | 0.160 |
| | 90 kg N $ha^{-1}$ | 3.10 | 0.200 fgh | 1.13 | 0.130 |
| | PKS but No N | 2.60 | 0.483 a | 1.52 | 0.250 |
| December,10 | No fertilizer | 2.11 | 0.163 h | 1.08 | 0.121 |
| | Cow dung 1 t $ha^{-1}$ | 2.22 | 0.320 bc | 1.28 | 0.180 |
| | 30 kg N $ha^{-1}$ | 2.28 | 0.237 defg | 1.16 | 0.152 |
| | 60 kg N $ha^{-1}$ | 2.33 | 0.210 efgh | 1.12 | 0.141 |
| | 90 kg N $ha^{-1}$ | 3.07 | 0.357 b | 1.17 | 0.152 |
| | PKS but No N | 2.71 | 0.450 a | 1.61 | 0.274 |
| Significance level | | NS | ** | NS | NS |
| $LSD_{0.05}$ | | -- | 0.525 | -- | -- |
| CV (%) | | 4.53 | 11.08 | 7.43 | 12.77 |

** Significant at 1% level; * Significant at 5% level;
In a column means having a common letter(s) are not differ significantly at 5% level of significant.

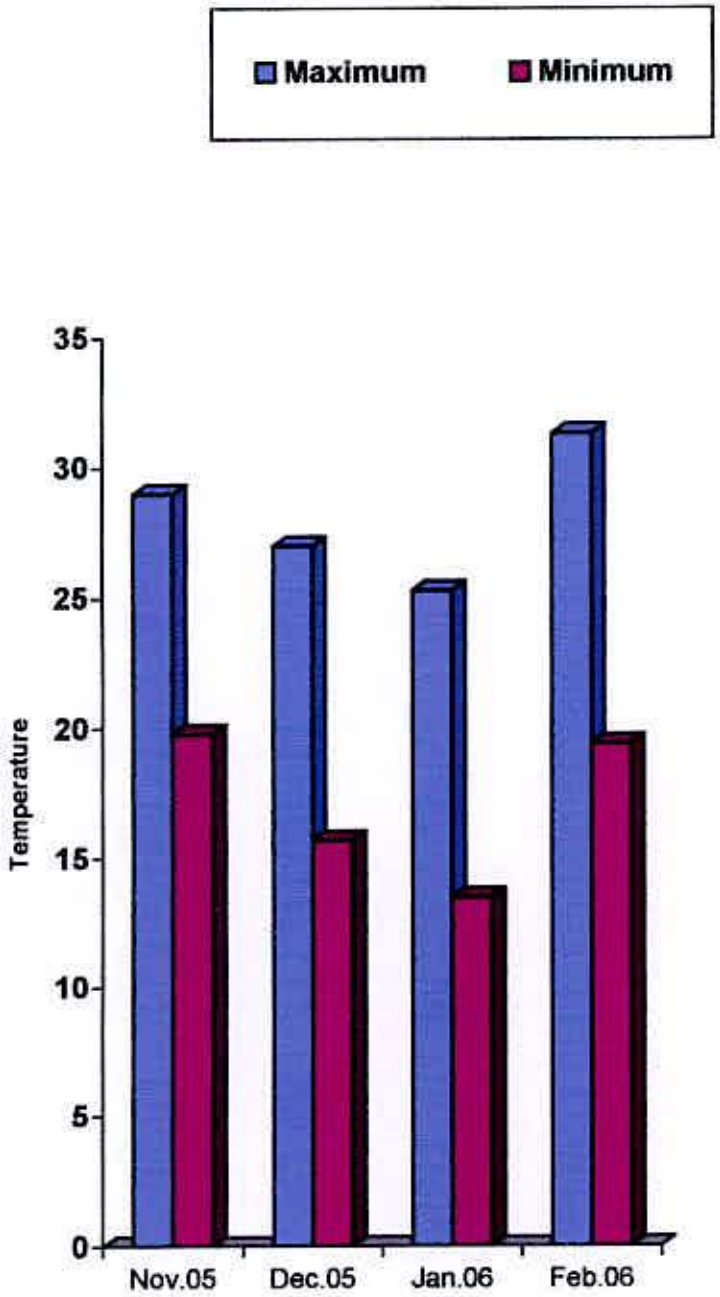


**Fig. 9 Monthly average max. and min air temperature. During Nov.05 to Feb.06.**

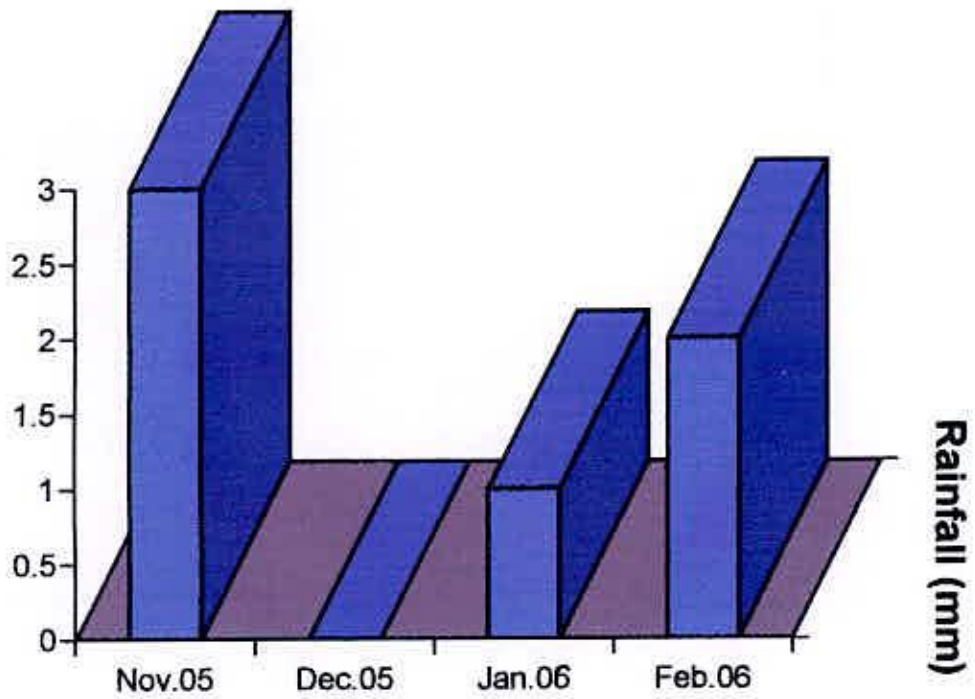


**Fig. 9 Monthly total rainfall (mm) during Nov.05,Dec.05,Jan.06 and Feb.06**

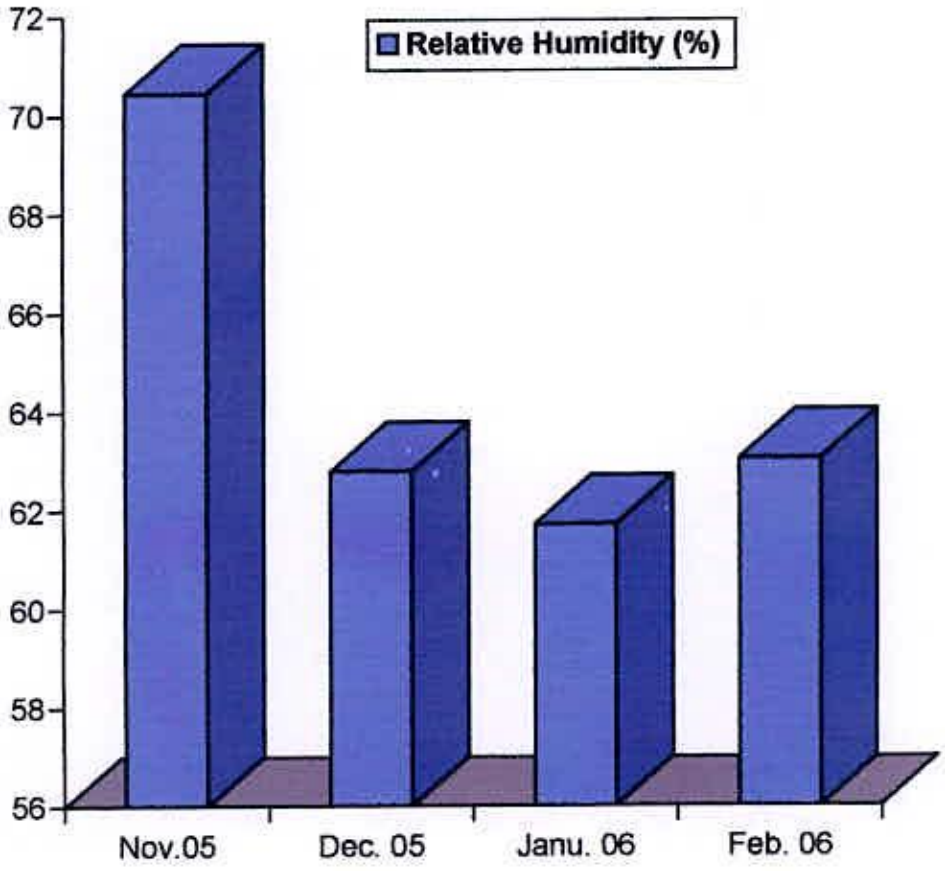


**Fig. 10 Monthly average relative humidity (%) during Nov'05 to Feb'06**