IN VITRO REGENERATION OF *DENDROBIUM* ORCHID WITH DIFFERENT MEDIA AND PGRs FROM PROTOCORM LIKE BODIES

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ACRONYMS

AEZ	=	Agro- Ecological Zone
BBS	=	Bangladesh Bureau of Statistics
BARI	=	Bangladesh Agricultural Research Institute
DAS	=	Days After Sowing
DAE	=	Days After Emergence
et al.	=	And others
etc	=	Etcetera
FAO	=	Food and Agricultural Organization
LSD	=	Least significant difference

NS	=	Non significant
RCBD		Randomizer Complete Block design
SAU	=	Sher-e- Bangla Agricultural University
Tk.	=	Taka

ABSTRACT

An experiment was conducted at the Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka during the period from August to October 2006 to study the effect of different levels of nitrogen viz. control (N_0), 50 kg N per hectare (N_1), 75 kg N per hectare (N_2), and 100 kg N per hectare (N_3) as well as different levels of P_2O_5 viz. control (P_0), 65 kg P_2O_5 per hectare (P_1), 75 kg P_2O_5 per hectare (P_2) and 85 kg P_2O_5 per hectare (P_3) on the growth and yield of Gimakalmi. The experiment was conducted in the Randomized Complete Block Design (RCBD) with three replications. Application of different levels of nitrogen significantly influence the growth and yield of Gimakalmi. The maximum (20.00g) fresh weight of leaves per plant was obtained from N_3 treatment while the minimum (18.66g) was found from control treatment (N_0) at 60 days after sowing. The highest (8.27g) dry weight of leaves per plant was observed in N_3 and the minimum (6.90g) was recorded from control treatment. The maximum (20.25g) fresh weight of leaves per plant was obtained from P_3 treatment and minimum (18.00 g) of fresh weight per plant was obtained from P_0 treatment.

The combined effect of various levels of nitrogen and P_2O_5 were also found significant incase of gimakalmi production. The highest yield (62.66 t/ha) was performed from the treatment combination in N_3P_3. The lowest yield (55.00t/ha) was obtained from the control treatment where no nitrogen and P_2O_5 were used. The benefit cost ratio (BCR) was maximum (3.00) in the treatment combination of N_3P_3 whereas the minimum (2.13) was recorded from the control treatment (N_0P_0).

INTRODUCTION

Gimakalmi (*Ipomoea reptans poir*) a leafy vegetable crop grown in Bangladesh, belongs to the family Convolvulaceae. It is an important leafy vegetable of the South-East-Asia, and is widely grown throughout the South East Asian countries. Australia and some parts of Africa (Hossain and Siddique, 1982). The crop is also known as Kangkong swamp cabbage, water convolvulus, water spinach etc. (Tindal, 1983). Leafy vegetables such as Gimakalmi, spinach, Indian spinach and amarnath are commonly close to "spinach group" of vegetables (Shinohara, 1980). Gimakalmi was developed from an introduced strain of Kangkong brought from Taiwan by the Horticulture Research centre, BARI, Gazipur (Rashid *et al.*, 1985). Spinach is usually recommended for enrichment of human diet, but unfortunately the crop can not be grown during the summer and rainy season in Bangladesh, while a serious scarcity of vegetable prevails during that time. Development of Gimakalmi is a good achievement, since this is suitable for growing both in summer and rainy season (Shinohara, 1978, 1980). Although similar, but aquatic type of local Kalmi is naturally grown in ponds or marshy land of Bangladesh, Gimakalmi is of special significance, because it grows in upland soil with an appreciable yield potential of foliage.

Application of fertilizer in judicious dose is one of the most important aspects of crop production. It is known that, nitrogen has a positive role in improving the vegetative growth of plants. Nitrogen increases the vegetative growth and produces good quality foliage and promotes carbohydrate synthesis (Rai, 1981). Early and rapid vegetative growth which is required for successful production of Gimakalmi is noticeably influenced by the nitrogenous fertilizers added to the soil. However, the optimum quantity of this fertilizer varies depending on agro-climatic situation. Literatures on the influence of different doses of nitrogenous fertilizers on the production of different vegetables are extensive, but limited on Gimakalmi.

Moreover, information on this crop under Bangladesh conditions is also limited. The use of nitrogenous fertilizer for the production of Gimakalmi is particularly important when several harvests are done from a single plant. In Bangladesh, urea is mostly used as the source of nitrogen and split application of this fertilizer is commonly practiced (Hossain, 1990). The harvest interval can also influence the yield of Gimakalmi. It has been recommended to start harvesting the crop at the 30th day after sowing (Anonymous, 1983a). The leaves and tender stems are the edible portion of this crop. Naturally hard fibrous shoots are unfit for consumption. So at the time of harvesting, two things are to be taken into consideration simultaneously-good quality and reasonable yield. One can not sacrifice much to achieve the other. Moreover, harvest interval is co-related with the application of nitrogen.

The effect of phosphorus on the formation and translocation of carbohydrates and root development, nodulation, growth and other agronomic characters are well recognized. Phosphorus induces earliness in flowering and maturity. Phosphorus also makes its contribution through its favorable effects on flowering and fruiting including seed formation. So, study of harvest interval is important. In the light of above context, the present experiment was undertaken to investigate the effect of four levels of nitrogen fertilizer and phosphorus on the growth and yield of Gimakalmi.

Considering the above factors, the present experiment was undertaken to study the following objectives.

1. To findout the proper dose of nitrogen.
2. To findout the proper dose of phosphorous.

3. To know the combined effect of nitrogen and phosphorous on gimakalmi in respect of growth and yield.

REVIEW OF LITERATURE

Nitrogen is most effective in increasing the yield of leafy vegetables compared to other nutrients (Salunkhe *et al.* 1980, Rai 1981) also reported that nitrogen increases the vegetative growth and produces good quality foliage and promotes carbohydrate synthesis. Gimakalmi is an introduced vegetable in Bangladesh. It is a spinach group leafy vegetable (Shinohara, 1980). Unfortunately, very little research has been done on this crop in Bangladesh. Experiments on the effects of nitrogen on leafy vegetable production have been conducted in various parts of the world, but research regarding the effect of nitrogen and harvest interval on the growth and yield of Gimakalmi is very limited. Studies on the effect of nitrogen on leafy vegetable production in different parts of the world have revealed that the yield is directly related to quantity of nitrogenous fertilizer application. In this section, an attempt has been made to review all the literatures available from home and abroad in relation to the effect of nitrogen and harvest interval on the growth and yield of Gimakalmi and other closely related spinach group vegetables, with the hope that, this may contribute useful information to the present study.

Effect of nitrogen

Park et al(1993) conducted an experiment on the effect of propagation method, planting density and fertilizer level on the growth of water spinach (*Ipomoea aquatica*), and reported that *Ipomoea aquatica* was successfully propagated from cuttings of length 30 cm, diameter ~1 cm and with 6 nodes, planting at a density of 30 X 30 cm, was better than either 15 cm X 15 cm or 45 cm X 45 cm and the application of N fertilizer at 30 kg per 10 acres increased yield more than lower

rates. Bruemmer and Roe (1979) reported that nitrogen had a positive effect to increase the yield of water spinach (*Ipomoea aquatica*).

Purushothaman (1978) conducted an experiment on the effects of nitrogen sources and levels on yield of some leafy vegetables in Malaysia, and he reported that in pot culture experiments with some Malaysian leaf vegetables, significant differences were observed between N sources and rates. For Kangkong (*Ipomoea reptans*) yield significantly increased up to 120 kg/ha.

A field experiment was carried out at IPSA, Salna, Gazipur during the Kharif season of 1986 to study the effect of manuring doses and harvest frequency on growth and yield of gimakalmi. Plant height, number of branches per plant, weight of foliage per plant were significantly increased by increasing manurial dose. Every increase in manurial dose was associated with significant increase in yield (Awal, 1989).

Shunphan and Postel (1985) observed an increase in yield of spinach up to 120 kg of nitrogen application per hectare. The doses of nitrogen in their study were 0, 30, 60, 120, 240 and 250 kg/h.

An investigation was carried out at the Bangladesh Agricultural University, Mymensingh in the year 1982 to study the influence of planting material and dose of nitrogen application on the yield of kangkong. There were two planting materials and five levels of nitrogen. The dosed of nitrogen were 0, 40, 80, 120 and 160 kg/ha. The result of the experiment revealed

that the application of N increased the yield and quality of kangkong. The influence of nitrogen was distinct at the second and third harvests. The application of 160 kg N/ha was found to be the best for seed propagated plants, while for the vegetatively propagated plants, the use of nitrogenous fertilizer appeared to be economic only up to the level of 80 kg N/ha. In addition to increase in yield, the added nitrogen improve the edible quality of the vegetable, particularly at the later harvests (Islam *et al.,* 1984).

Wiggans et al (1963) reported that an application in spinach of about 60 kg nitrogen per hectare within two weeks of planting was generally adequate for optimum growth, but supplementary top-dressing up to 120 kg/ha was beneficial.

Salaj and Jasa (1965) in a trial on the nutrient requirement of spinach found a significant effect of nitrogen on yield of leaf size. They obtained maximum yield with 60 kg,\ N, 2 kg P_2O_5 and 60 kg K_2O/ha. Similarly, Smith and Saloman (1974) observed a positive correlation between yields and nitrogen application in spinach for the entire periods of growth.

Bhore and Patil (1978) in an experiment sew spinach in rows 20 cm apart and the effects were compared of a soil application of N as urea at 100 kg/ha 12 days after sowing either alone or followed by one or two foliar sprays, each at 2.3 kg N/ha, 4+4 days later. Yield were markedly enhanced by all treatments, soil + 2 foliar applications giving the best results (250 q/ha, compared with 85 q/ha for N controls).

Bangladesh Agriculture Research Institute (BARI) has carried out some studies on batisak since its introduction in the country (Annon., 1984); Miah, 1987; Zaman and Rahaman, 1988. Nitrogen was reported to be the most important fertilizer to control plant growth and yield. It was found that yield of batisak increased with an increase in nitrogen level from 80 kg to 172 kg per hectare in Mymensingh condition (Miah, 1987).

Aditya *et al* (1995) conducted an experiment of effect of spacing and different levels of nitrogen on the production of pak choi (*Brassicaa chinensis* L.) cv. Batisak at the Horticulture farm of the Bangladesh Agricultural University, Mymensingh. They reported that spacing and application of nitrogen significantly influenced the growth and yield of Batisak. In increasing level of nitrogen, yield increased and maximum yield per hectare in both fresh and dry weight was obtained with 200 kg nitrogen per hectare.

Dhillon *et al.* (1987) conducted an experiment on effect of different levels of nitrogen on yield and chemical composition of spinach (*Ipomoea oleracea*) and they reported that in field trials over 2 years with the cv. Punjab selection, N was applied as urea at 0-90 kg/ha with a P K basal dressing. The average leaf yield rose with increasing N rate from 20.4 t/ha at zero kg N to 41.2t/ha at the highest N rate. Leaf N content rose with increasing N rate leaf Fe, Mn contents decreased, contents of P, K, S, and Zn were unaffected.

Verma *et al.* (1969) conducted an experiment on spinach (*Spinacia oleracea*) where nitrogen was applied to a spinach crop at 80, 160, and 200 kg/ha. Increasing levels of nitrogen increased yield and the ascorbic acid content was positively but not significantly related to N levels.

In the results of four years, experimental work, spinach yields were closely related to available nitrogen and except in soils already rich in nitrogen, the response to ammonium nitrate applied 2 or 3 times during the growing seasons was very marked. There was no definite response to K, but the highest k rate 120 kg/ha K_2O in combination with high nitrogen increased the yield (Cervato, 1969).

Westgate *et al.* (1958) conducted an experiment on improvement of the cultural practices for leafy vegetable crops. They reported that, compared to other nutrients, nitrogen is most effective in increasing the yield of leafy vegetables.

Chowdhury *et al.* (1974) studied on the effect of different spacing and levels of nitrogen on the yield of spinach. They observed that the yield of spinach significantly increased with higher levels of nitrogen. The favorable effect of the higher level of nitrogen was reflected in a larger number of leaves per plant and bigger size of the leaves.

Etmam (1993) conducted an experiment on response of spinach to soil and urea fertilization. He observed that increasing soil application of nitrogen from 50 to 100 kg urea/feddan (1 feddan = 0.42ha) increased yield. The combination of 50 kg/feddan to the soil and 25 kg/feddan as a foliar spray resulted in the highest yield, as a result of increased leaf area,

number of leaves/plant and shoot weight and length. There were significant positive correlations between yield and shoot weight, shoot length, number of leaves per plant, leaf area and shoot dry matter.

Leafy vegetable crops required more nitrogen, and higher nitrogen levels increased the yield and dry matter content of the tops (Verma *et al*, 1969 ;) Chowdhury et al, 1974. Kangkong responds to nitrogen fertilizers applied either before planting or as subsequent top0dressing (Tindal, 1983).

Hamid *et al.* (1986) conducted an experiment of the effect of nitrogenous fertilizers on growth and yield of Indian spinach, and significant variations were observed among the different nitrogen treatments in respect of number of shoot/plant, number of leaves/plant, shoot length and breadth, and yield. The highest yield (79.34 t/ha) was obtained by applying the highest nitrogen dose (250kg N/ha).

Rahman *et al.* (1985a) studied on Indian spinach and reported that the highest yield of greens (62.89 t/ha) was obtained from the spacing when the highest dose of nitrogenous fertilizer was applied. For the application of N-levels, all the characters different significantly at 1% level of significance. However, the maximum number of shoots (88) was produced from the highest application (82.8kg N i.e. 180 kg urea/ha) and this seemed to contribute towards the highest yield.

For obtaining good yield and high quality shak in Gimakalmi 150 kg urea per hectare should be applied (Rashid, 1993; Anonymous, 1980; Anonymous, 1983b).

Rashid *et al*. (1981) studied on the acclimatization, adaptability and performance of Kangkong (*Ipomoea aquatica*) and they reported that the yield was significantly increased by increasing the application of nitrogen levels up to certain limit. The above finding is in support of another report (Anonymous, 1982). In another experiment (Anonymous, 1983b) the highest yield of Gimakalmi was obtained from a higher basal dose (75 kg/ha) and top-dressing (50kg/ha) of urea.

MATERIALS AND METHODS

3.1 Experimental site:

The present experiment was conducted at the Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka, during the period from August to October 2006. The experimental site was previously used as vegetable garden and recently developed for research work. The location of the site in $23^0 74^/$ N latitude and 90^0 $35^/$ E longitudes with an elevation of 8.2 meter from sea level.

3.2 Climate

The experimental area was under the sub-tropical climate. The total rainfall of the experimental site was 200 mm during the study period. The average monthly maximum and minimum temperature were 35.7^0C and 21.8^0C respectively during the experimental period. The Maximum and minimum temperature, humidity, rainfall and soil temperature during the study period were collected from the Bangladesh Meteorological Department (Climate Division) Dhaka and have been presented (Appendix I).

3.3 Soil

The soil of the experimental area belongs to the Modhupur Tract (UNDP, 1988). The analytical data of the soil sample collected from the experimental area were determined in the SRDI, Soil Testing Laboratory, Khamarbari, Dhaka have been presented in appendix II. The soil of the experimental area was silty. The selected plot was medium high land and its pH

value was around 5.6. The morphological characters of soil of the experimental plots as indicated by FAO (1988) are given below- AEZ No.28

Soil series-Tejgaon

General soil-Non calcarious dark grey.

3.4 Materials

In this research work, Gimakalmi seed was used as planting material, and manure and fertilizers viz., well decomposed cowdung, urea, triple super phosphate and muriate of potash were used as the sources of plant nutrients. The seeds of gimakalmi were collected from Bangladesh Agricultural Research Institute. Seeds of gimakalmi were used @ 10 kg/ha.

3.5 Two factors in the experiment

Factor: A Nitrogen level

N_0 = Control

N_1 = 50 kg N/ha

N_2 = 75 kg N/ha

N_3= 100 kg N/ha

Factor: B Phosphorus level

P_0 = Control

P_1 = 65 kg P_2O_5 /ha

P_2 =75 kgP_2O_5/ha

P_3 = 85 kg P_2O_5/ha

Experimental treatments combination

N_0P_0	N_3P_1
N_1P_2	N_oP_3
N_3P_0	N_2P_2
N_2P_1	N_1P_0
N_3P_2	N_2P_3
N_1P_3	N_0P_2
N_0P_1	N_1P_1
N_2P_0	N_3P_3

3.6 Experimental design and layout

The two factors experiment was laid out following Randomized Complete Block Design (RCBD) with three replications. An area of 32.7 m x 8.5 m was divided into three equal blocks. Each block was divided into 48 plots where 16 treatments were allotted at random. Thus there were 48 unit plots altogether in the experiment. The size of each plot was 1.5m x 1.2m. The distance between two blocks and two plots were kept 1 m. and 0.5 m. respectively. A layout of the experiment has been shown in Fig.1.

3.7 Land preparation

The land was opened with a tractor during the month of August 2006. The land was ploughed and cross- ploughed several times followed by laddering and harrowing to obtain a good tilth. The land was leveled and the corners of the plots were trimmed with spade and large clods were broken into small pieces as far as possible. All the weeds and stubbles were removed, and the land was finally prepared five days before sowing of seeds.

3.8 Application of manure and fertilizers

Manure & fertilizer were applied according to the treatment in each plot. These were given as follows:

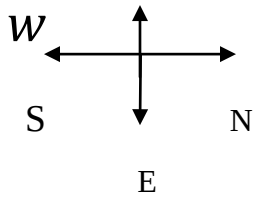
Manure and fertilizers	Doses/ ha
Cowdung	10 ton
Muriate of potash (MP)	25 kg
N (as urea)	0,50, 75, 100 kg /ha
P_2O_5 (as TSP)	0,65,75, 85 kg/ha

The entire amount of cowdung and muriate of potash were applied during the final land preparation. The whole amount of urea were applied in equal 3 splits as per treatment in the plot after 1st 15 , 2nd 30 and 3rd 45 days after sowing.

The entire triple super phosphate were applied during final land preparation as basal dose in the plots as per treatments. Cowdung, Triple super phosphate and muriate of potash were applied thoroughly mixed with the soil.

Layout and design of experiment

N_0P_0		N_1P_1	N_2P_1
N_1P_2		N_0P_0	N_0P_2
N_3P_0	1 m	N_3P_3	N_1P_3
N_2P_1		N_0P_1	N_3P_0
N_3P_2		N_3P_2	N_1P_2
N_1P_3		N_2P_0	N_2P_3
N_0P_1		N_3P_1	N_0P_0
N_2P_0		N_2P_2	N_1P_1
N_3P_1		N_2P_1	N_0P_3
N_0P_3		N_1P_3	N_3P_2
N_2P_2		N_0P_2	N_2P_2
N_1P_0		N_1P_0	N_1P_0
N_2P_3		N_2P_3	N_0P_1
N_0P_2		N_3P_0	N_3P_3



Plot size: 1.5 x 1.2m
Block spacing: 1 m.
Plot spacing: 0.5 m.

N_0=Control

N_1= 50 kg N/ha

N_2= 75 kg N/ha

N_3= 100 kg N/ha

P_0=Control

P_1= 65 kg P_2O_5 /ha

P_2= 75 kg P_2O_5/ha

P_3= 85 kg P_2O_5/ha

N_1P_1	N_1P_2	N_2P_0
N_3P_3	N_0P_3	N_3P_1

Fig.1 Field layout of the two factors experiment in the Randomized Complete Block Design (RCBD).

3.9 sowing of Seeds

Direct sowing method was followed in this experiment and seeds were sown on 15 August 2006. Two seeds were sown in each planting hole at one cm depth and covered with a thin layer of soil. The rows were place 30 cm apart while the spacing between the plants in a row was 15 cm. Thinning was done on seven days after emergence and only one seedling was

allowed to grow in each location. Finally, 40 plants were kept in a plot. Seeds were also sown around the experimental area to check the border effect.

3.10 Intercultural operation

The plants were kept under careful observation. Weeding was done as and when necessary and mulching was done immediately after the application of urea. The plots were irrigated by water can to ensure equal water supply in each unit plot as and whenever necessary. At the time of irrigation, care was taken so that no water logging condition occurred at any place of the experimental area. No insecticides or fungicides were applied since there was no problem of insect or disease infestation.

3.11 Harvesting

The first harvest was done from all plots at 30 days after sowing. The plants were cut at a height of 7-8 cm from the ground level and data were recorded on several characters. The crop was allowed to grow and harvests were done at 60 days after sowing respectively.

3.12 Collection of data

Ten plants were randomly selected from each unit plot for the collection of data. Data were collected in respect of the following characters.

3.12.1 Plant height (cm)

Plant height was measured in centimeter from the ground level to the tip of the stem at 10, 20, 30, 40, 50, 60 days after sowing and the average was taken.

3.12.2 Number of branches per plant

The number of branches was counted (10,20,30, 40, 50, 60 days after sowing) from ten randomly selected plants and their average was calculated.

3.12.3 Number of leaves per plant

The number of leaves was counted (at 10, 20, 30, 40, 50, 60 days after sowing) from the ten randomly selected plants and their average was calculated as the number of leaves per plant.

3.12.4 Fresh weight of leaves per plant (gm)

Leaves of ten randomly selected plants (from each plot) at 30 and 60 DAS were detached by a sharp knife and average fresh weight of leaves were recorded in gram (g). An analytical beam balance was used to take the weight of foliage.

3.12.5 Dry weight of plant (g)

Plant cut into thin pieces were sun dried after that samples were placed in envelop, were weighed and placed in oven maintained at 70^0C for 72 hours. The sample then was transferred into desiccators and allowed to cool down to the room temperature. The dry weight of the sample was taken per plant with help of electric balance.

3.12.6 Yield per plot (g)

Foliage yield per plot was recorded by harvesting all plants in each plot and taking their weight by a simple balance.

3.12.7 Yield per hectare (t)

Yield of foliage per plot was converted into yield per hectare (ton).

3.13 Cost and return analysis

The cost and return analysis were done. Materials (1A), non materials (1B) and over head cost were recorded for all the treatments of unit plot and calculated on per hectare basis.

3.14 Statistical analysis

The recorded data on different characters were statistically analyzed to find out the significance of difference among the treatment means. The data recorded on first harvest were analyzed as single factor (nitrogen) experiment in RCBD with three replications. The data recorded and analyzed as two (nitrogen levels and phosphorus levels factor experiment in RCBD. However, the total yields were analyzed as two factor experiment in RCBD, considering the levels of nitrogen as one factor, and the levels of phosphorus another factor. The mean values of different characters for all treatments were

calculated and the analysis of variance for all the characters under study was performed by F (variance ratio) test. The mean differences were evaluated by Least Significant Difference Test as suggested by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

The experiment was conducted to investigate the effect of different levels of nitrogen and phosphorus on the growth and yield of gimakalmi. The analyses of variances for different characters have been presented in appendix III and IV data of the different parameters analyzed statistically and the results have been presented in the Table 1 to 16 and Figures 2 to 7. The results of the present study have been presented and discussed in this chapter under the following headings.

4. Effects of nitrogen and phosphorus on growth and yield of Gimakalmi

4.1. Effect of Nitrogen and Phosphorus on Plant height

The level of nitrogen application had marked influence on plant height of gimakalmi at different stages of growth i.e. 10, 20,30,40.50 and 60 days after sowing. The plant height was found to be increased significantly with the increase in nitrogen level up to 100 kg/ha (Table 1). At 60 DAS the maximum plant height (64.16 cm) was observed in N_3 treatment was applied at 45 days after sowing. In general, plant height increased gradually in the early stages. The minimum plant height (51.08 cm) was found in control plot (N_0) at 60 days after sowing. Similar results were found in lettuce by Karacal and Turetken (1972).

The application of phosphorus influences the plant height of **g**imakalmi significantly. The highest plant height (62.50 cm) was obtained from P_3 treatment at 60 DAS. The lowest (53.21cm) plant height was found in P_0 (Control treatment). (Table 2). Application of phosphorus resulted the good root system which ultimately helps plant growth.

The plant height was significantly influenced by the interaction effect of nitrogen and phosphorus application on gimakalmi. The combined effect of Nitrogen and Phosphorus at different days after sowing was also significant (Appendix III). The maximum height was recorded at 60 DAS. The highest plant height of 68.83 cm was found from N_3P_3 treatment combination and the lowest (57.33cm) was recorded from the control treatment (N_0P_0) at 60 DAS (Table 3).

Table 1. Main effect of nitrogen on plant height (cm) at different days after sowing.

Treatment	10 DAS	20D AS	30 DAS	40 DAS	50 DAS	60 DAS
N_0	5.97	14.77	26.00	35.41	41	51
N_1	6.15	15.87	26.33	37.83	46	57
N_2	6.99	16.20	27.00	36.91	45	56
N_3	7.32	17.33	28.16	39	52	64.16
LSD (0.05)	0.25	4.86	19.66	5.76	19.44	19.45
CV %	5.22	7.02	10.11	6.75	7..67	9.22

N_0 = Control
N_1 = 50 kg N/ha
N_2 = 75 kg N/ha
N_3 = 100 kg N/ha

Table 2. Main effect of phosphorus on plant height (cm) at different days after sowing

Treatment	10 DAS	20 DAS	30 DAS	40 DAS	50 DAS	60 DAS
P_0	5.79	15.04	25.75	34	45	53.33
P_1	6.01	15.41	27	37	48	56
P_2	6.27	15.25	27.83	39	51	61
P_3	7.30	15.91	28.00	40.25	53.11	62.50
LSD (0.05)	0.41	2.47	3.69	2.00	3.67	3.67
CV %	7.12	6.92	9.52	11.22	10.51	7.59

P_0 = Control
P_1 = 65 kg P_2O_5/ha
P_2 = 75 kg P_2O_5/ha
P_3 = 85 kg P_2O_5/ha

Table 3. Combined effect of nitrogen and phosphorus on plant height (cm) at different DAS

Treatment Combinations	10. DAS	20.DAS	30. DAS	40. DAS	50. DAS	60. DAS

N_0P_0	6.60	16.16	26.00	35.33	46.66	57.33
N_0P_1	5.30	15.66	26.11	37	49.24	60.11
N_0P_2	6.20	15.66	26.33	38.33	48.99	59.22
N_0P_3	6.41	15.30	29.00	41.00	53.00	64.66
N_1P_0	6.23	14.60	26.66	37	49.00	62.33
N_1P_1	6.56	15.83	27.00	38	49.99	61.99
N_1P_2	6.36	15.33	26.33	38.99	50.00	63.33
N_1P_3	5.43	15.16	26.00	37.00	49.00	62.00
N_2P_0	5.76	15.50	26.33	39.00	51.33	64.33
N_2P_1	5.63	15.00	24.00	38.66	50.00	62.31
N_2P_2	5.00	14.83	28.33	40.22	52.00	65.00
N_2P_3	6.33	15.50	28.00	40.00	52.99	65.33
N_3P_0	6.00	15.66	27.66	39.00	51.22	64.11
N_3P_1	6.56	13.66	24.00	36.00	49.33	60.66
N_3P_2	5.73	16.00	29.66	41	53.00	65.00
N_3P_3	6.81	16.33	31.33	43.33	55.22	68.83
LSD (0.05)	0.83	3.67	7.39	4.00	7.35	7.35
Levels of significant	*	**	**	NS	**	**

**Significant at 1% level
* Significant at 5% level
NS=Non-significant
N_0 = Control
N_1 = 50 kg N/ha
N_2 = 75 kg N/ha
N_3 = 100 kg N/ha

P_0 = Control
P_1 = 65 kg P_2O_5 /ha
P_2 = 75 kg P_2O_5 /ha
P_3 = 85 kg P_2O_5 /ha

4.2 Effect of Nitrogen and Phosphorus on number of leaves per plant

Application of nitrogen significantly increases the number of leaves per plant (Table 4) at different days after sowing. The highest (56.41) number of leaves was observed in N_3 at 60 DAS which was statistically identical with N_2 (54.25). The lowest (51.50) number of leaves found in N_0 treatment which was statistically different from N_1 (53.83). From the observation it was found that with increasing level of nitrogen application number of leaves increased.

Significant variation was found in case of production of leaves per plant due to the effect of phosphorus (Table 5) at different DAS. At 60 DAS P_3 phosphorus treatment produced the maximum (57.25) number of leaves, followed by P_2 (54.75). The control treatment gave the minimum number of leaves (52) per plant.

The number of leaves per plant was also significantly influenced by the interaction effect of nitrogen and phosphorus (Appendix III) at different days after sowing. At 60 DAS the plant received the treatment N_3P_3 and produced the highest (61.66) number of leaves. The lowest (41.66) number of leaves was recorded from the control treatment, where no nitrogen and P_2O_5 were added (Table 6).

Table 4. Main effect of nitrogen on the number of leaves per plant at different days after sowing

Treatment	10 DAS	20 DAS	30 DAS	40 DAS	50 DAS	60 DAS
N_0	5.00	14.29	24.50	32.66	43.08	51.50
N_1	5.33	14.75	25.16	34.25	46.91	53.83
N_2	5.41	15.66	26.41	38.25	46.81	54.25

N_3	6.16	16.25	27.00	39.75	49.99	56.41
LSD (0.05)	0.16	3.69	2.48	1.40	23.40	23.05
CV %	8.22	7.91	11.51	6.32	5.79	7.69

N_0 = Control

N_1 = 50 kg N /ha

N_2 = 75 kg N /ha

N_3 = 100 kg N /ha

Table 5. Main effect of phosphorus on the number of leaves per plant at different days after sowing

Treatment	10 DAS	20 DAS	30 DAS	40 DAS	50 DAS	60 DAS
P_0	5.00	15.04	24.58	31.41	42.58	52.00
P_1	5.33	15.20	24.75	35.83	43.08	53.66
P_2	5.50	15.20	26.25	36.41	48-.66	54.75
P_3	6.08	15.89	27.5	39.58	51.41	57.25
LSD (0.05)	0.33	1.60	1.31	0.98	5.03	4.00
CV %	9.345	7.67	5.96	10.91	7.52	9.72

P_0 = Control

P_1 = 65 kg P_2O_5/ha

P_2 = 75 kg P_2O_5/ha

P_3 = 85 kg P_2O_5/ha

Table 6. Combined effect of nitrogen and phosphorus on number of leaves per plant at different days after sowing

Treatment Combinations	10 DAS	20 DAS	30 DAS	40 DAS	50 DAS	60 DAS
N_0P_0	5.00	13.66	20.00	28.66	37.66	41.66
N_0P_1	5.33	14.66	24.33	31.66	39.33	46.00
N_0P_2	5.33	14.66	23.66	31.00	41.00	53.33
N_0P_3	5.66	14.16	27.00	33.00	41.66	51.33
N_1P_0	5.31	14.667	24.66	31.33	43.00	53.33
N_1P_1	6.02	14.83	20.00	30.33	41.00	53.33
N_1P_2	5.66	14.00	23.00	32.33	43.33	54.33
N_1P_3	5.00	15.50	26.33	34.33	45.33	55.00
N_2P_0	5.00	15.66	20.33	32.66	43.66	58.33
N_2P_1	5.33	15.33	24.00	35.00	46.00	58.00

N_2P_2	6.00	16.00	25.66	36.66	48.66	56.00
N_2P_3	5.33	15.66	26.66	38.66	49.33	56.33
N_3P_0	5.33	16.16	26.63	37.33	51.00	57.00
N_3P_1	5.88	16.00	27.00	39.00	51.33	58.33
N_3P_2	6.00	16.16	29.00	40.33	53.66	59.00
N_3P_3	6.00	16.66	30.00	43.66	55.66	61.66
LSD (0.05)	0.67	3.20	2.62	1.97	8.06	8.00
Levels of significant	**	NS	**	**	NS	**

**Significant at 1% level
* Significant at 5% level
NS= Non-significant
N_0 = Control
N_1 = 50 kg N/ha
N_2 = 75 kg N/ha
N_3=100 kg N/ha

P_0 = Control
P_1 = 65 kg P_2O_5/ha
P_2 = 75 kg P_2O_5/ha
P_3 = 85 kg P_2O_5/ha

4.3. Effect of nitrogen and phosphorus on number of branches per plant

Application of nitrogen significantly increases the production of branches per plant (Table 7) at different stages of growing. At 60 DAS the highest (7.16) number of branches were observed in N_3 which was not statistically significant with N_2 (7.08). The lowest (5.25) number of branches found from N_0 treatment. From the observation it was found that with increasing level of nitrogen application the number of branches were increased. This results in agreement with that of Islam et al (1988) in Batista This finding coincided with that of Islam *et al.* (1986).

Significant variation was found in production of branches per plant due to the effect of phosphorus (Table 8) at different DAS. It recorded that in 10 DAS no branches were observed. At 60 DAS P_3 treatment produce the maximum (7.08) number of branches which was followed by P_2 (6.41). The control treatment gave the minimum (6.00) number of branches per plant showing significantly different result from other treatments.

The number. of branches per plant was also significantly influenced by the interaction effect of Nitrogen and Phosphorus (Appendix III). At 60 DAS the plant received the treatment N_3P_3 and produced the highest number of branches (8.00). The lowest number of branches (4.14) was observed form the control treatment where no nitrogen and phosphorus were added (Table 9).

Table 7. Main effect of nitrogen on the number of branches per plant at different days after sowing

Treatment	10. DAS	20.DAS	30. DAS	40. DAS	50. DAS	60. DAS
N_0	0	1.79	3	3.11	4.00	5.25
N_1	0	1.83	3.41	3.96	4.66	5.99
N_2	0	2.13	3.45	4.00	5.16	7.08
N_3	0	3.11	3.62	4.83	6	7.16
LSD (0.05)	0	0.01	0.04	0.16	0.35	0.16
CV %	0	0.16	0.39	0.49	0.33	0.91

N_0 = Control

N_1 = 50 kg N/ha

N_2 = 75 kg N/ha

N_3 = 100 kg N/ha

Table 8. Main effect of phosphorus on the number of branches per plant at different days after sowing

Treatment	10 DAS	20 DAS	30 DAS	40 DAS	50 DAS	60 DAS
P_0	0	1.62	3.21	4.91	5.00	6.00
P_1	0	2.13	3.29	5.75	5.16	6.25
P_2	0	2.33	3.20	5.41	5.25	6.41
P_3	0	3.00	3.98	5.99	6.00	7.08
LSD (0.05)	0	0.10	0.16	0.33	0.49	0.33
CV %	0	6.92	7.98	10.12	9.59	7.92

P_0 = Control

P_1 = 65 kg P_2O_5/ha

P_2 = 75 kg P_2O_5/ha

P_3 = 85 kg P_2O_5 /ha

Table 9. Combined effect of nitrogen and phosphorus on number of branches per plant at different days after sowing

Treatment Combinations	10 DAS	20 DAS	30 DAS	40 DAS	50 DAS	60 DAS
N_0P_0	0	1.00	2.33	3.33	4.33	4.14
N_0P_1	0	2.00	3.33	5.33	5.33	4.65

N_0P_2	0	2.00	3.12	4.33	5.66	5.33
N_0P_3	0	1.66	3.66	5.66	6.33	5.00
N_1P_0	0	1.83	3.33	5.33	6.00	6.00
N_1P_1	0	2.50	3.00	5.33	5.00	5.66
N_1P_2	0	1.86	2.66	5.66	6.65	4.62
N_1P_3	0	2.33	3.33	5.33	7.33	5.00
N_2P_0	0	2.12	3.66	5.66	6.33	5.33
N_2P_1	0	1.50	2.83	5.00	7.00	5.01
N_2P_2	0	2.66	3.66	6.33	6.26	5.33
N_2P_3	0	2.00	3.52	5.33	623	5.66
N_3P_0	0	2.33	3.66	6.66	6.33	5.05
N_3P_1	0	1.00	3.66	6.00	7.33	5.33
N_3P_2	0	2.00	2.83	5.33	7.33	6.66
N_3P_3	0	3.26	4.00	7.33	7.66	8.00
LSD (0.05)	0	0.20	0.33	0.67	0.98	0.67
Levels of significant		**	**	NS	**	*

**Significant at 1% level
* Significant at 5% level
NS= Non-significant
N_0 = Control
N_1 = 50 kg N/ha
N_2= 75 kg N/ha
N_3=100 kg N/ha

P_0 = Control
P_1 = 65 kg P_2O_5/ha
P_2 = 75 kg P_2O_5 /ha
P_3 = 85 kg P_2O_5 /ha

4.4 Effect of nitrogen and Phosphorus on fresh weight of leaves per plant (g)

At first harvest (30 DAS), the maximum (14.00 g) fresh weight of leaves was recorded from N_3 treatment which was followed by N_2 (13.16g) and N_1(13.08 g) while the minimum (11.75 g) was observed in N_o (control) treatment. On the other hand at second harvest (60 DAS), the maximum (20 g) fresh weight was found in N_3 and the minimum (18.66g) observed in control treatment where no nitrogen was applied (Table 10). The present findings either partially or fully agree with the previous works of El-Hassan (1990); Anez and Pino (1997) and Kowalska (1997). Nitrogen promote vegetative growth which ultimately increase the yield .

Significant variation was observed for fresh weight of leaves due to different level of phosphorus application. In case of first harvest (30 DAS) the maximum (13.33g) fresh weigh of leaves was observed in P_3 while the minimum (10.00 g) was recorded from P_O treatment. At 60 DAS the maximum (20.25g) fresh weight of leaves was found from P_3 which was not identical with P_2 (19.25g) treatment and the minimum (18.00g). fresh weight of leaves was found in P_0 treatment.

The significant interaction effect of nitrogen and phosphorus was observed on fresh weight of leaves per plant. The combined effect of nitrogen and phosphorus was also significant on fresh weight of leaves per plant. At 30 DAS (first harvest) he maximum (16.66 g) fresh weight of leaves was recorded from N_3P_3 treatment combination and minimum (10.00g) fresh weight of leaves were found from NoP_O treatment combination. At 60 DAS the maximum fresh weight of leaves (22.01g.) was obtained from N_3P_3 treatment combination which was not statistically similar with other treatment and the lowest fresh weight of leaves (15.33 g.) was found in N_0P_0 treatment combination.

Table **10. Main effect of nitrogen on the fresh weight of leaves (g) per plant at different days after sowing**

Treatment	1st harvest(30 DAS)	2nd harvest(60 DAS)
N_0	11.75	18.66
N_1	13.08	19
N_2	13.16	19.66
N_3	14.00	20.00
LSD (0.05)	5.67	0.16
CV %	9.72	7.91

N_0 = Control

N_1 = 50 kg N/ha

N_2 = 75 kg N/ha

N_3 = 100 kg N/ha

Table 11. Main effect of phosphorus on the fresh weight of leaves (g) per plant at different days after sowing

Treatment	1st harvest(30 DAS)	2nd harvest(60 DAS)
P_0	10.00	18.00
P_1	12..16	19.15
P_2	12.66	19.25
P_3	13.33	20.25
LSD (0.05)	1.98	0.33
CV %	9.22	10.01

P_0 = Control

P_1 = 65 kg P_2O_5/ha

P_2 = 75 kg P_2O_5/ha

P_3 = 85 kg P_2O_5/ha

Table 12. Combined effect of nitrogen and phosphorus on the fresh weight of leaves at different days after sowing

Treatment Combinations	1st harvest (30 DAS)	2nd harvest (60 DAS)
N_0P_0	10.00	15.33
N_0P_1	13.00	20.66
N_0P_2	13.66	21.66
N_0P_3	15.00	21.66
N_1P_0	15.00	21.02
N_1P_1	13.33	18.66
N_1P_2	11.12	18.33
N_1P_3	10.66	18.66
N_2P_0	12.00	19.00
N_2P_1	12.66	18.38
N_2P_2	13.00	20.00
N_2P_3	11.66	18.66
N_3P_0	14.00	21.66

N_3P_1	11.00	19.33
N_3P_2	14.33	20.00
N_3P_3	16.66	22.01
LSD (0.05)	1.82	3.97
Levels of significant	**	*

**Significant at 1% level
* Significant at 5% level
N_0 = Control
N_1 = 50 kg N /ha
N_2= 75 kg N /ha
N_3= 100 kg N /ha

P_0 = Control
P_1 = 65 kg P_2O_5/ha
P_2 = 75 kg P_2O_5/ha
P_3 = 85 kg P_2O_5/ha

4.5. Effect of nitrogen and Phosphorus on the dry weight of plant (g) at different days after sowing

The dry weight of Plant also varied significantly with different nitrogen levels. At first harvest (30 DAS) the dry weight of plant was recorded to be the highest (6.53 g) where N_3 treatment was applied and the lowest (5.75 g) was obtained from the control treatment (No). The dry weight of plant was recorded to be the highest (8.27g) where N_3 treatment was applied and the lowest dry weight of plant (6.90 g) was obtained from the control treatment (No) at 60 DAS (Fig -2). The possible reason regarding high dry weight of plant is that proper dose of nitrogen uptake other nutrient in balance condition which accumulated more plant nutrient that gave more dry matter in plant.

Application of phosphorus showed significant influence on the dry weight of plant in gimakolmi. Incase of first harvest (30 DAS) the maximum (6.30 g) dry weight of plant was recorded in P_3 while the minimum (5.20 g) dry weight was observed in P_0 treatment. At 60 DAS (2nd harvest) the maximum (8.50 g) was found from P3 treatment followed by P_2 treatment (7.92) and the minimum (7.00 g) in this respect was found from the control treatment (Po). (Fig-3).

Both the nitrogen and phosphorus effect were significant in respect of dry weight of plant of gimakolmi. At First harvest (30 DAS) the maximum dry weight (7.56 g) of plant was observed in N_3P_3 treatment and the minimum (5.20 g) dry weight was recorded from the control treatment N_0P_0. However, at 60 DAS the maximum dry weight of plant (9.20 g) was observed in the treatment combination N_3P_3 treatment and the minimum dry weight (6.36 gm) was recorded from the control treatment. (Table 13).

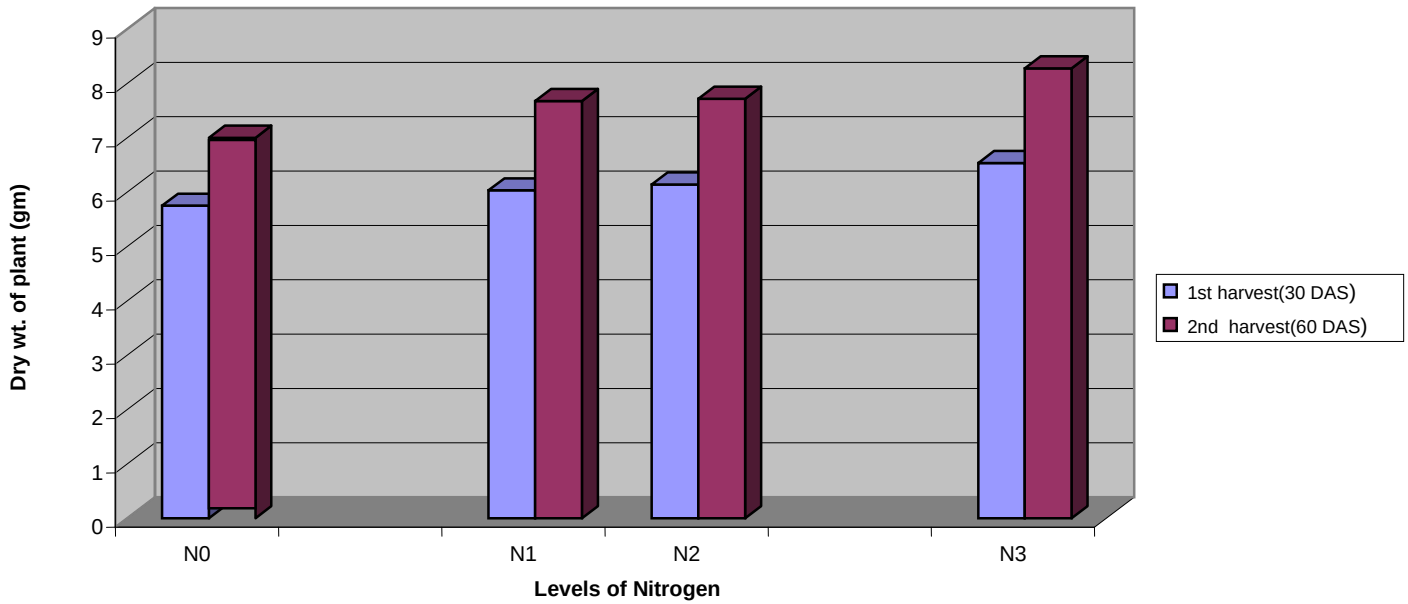


Fig: 2. Main effect of nitrogen on the Dry weight of plant (g) at different days after sowing

N_0 = Control

N_1 = 50 kg N/ha

N_2 = 75 kg N/ha

N_3 = 100 kg N/ha

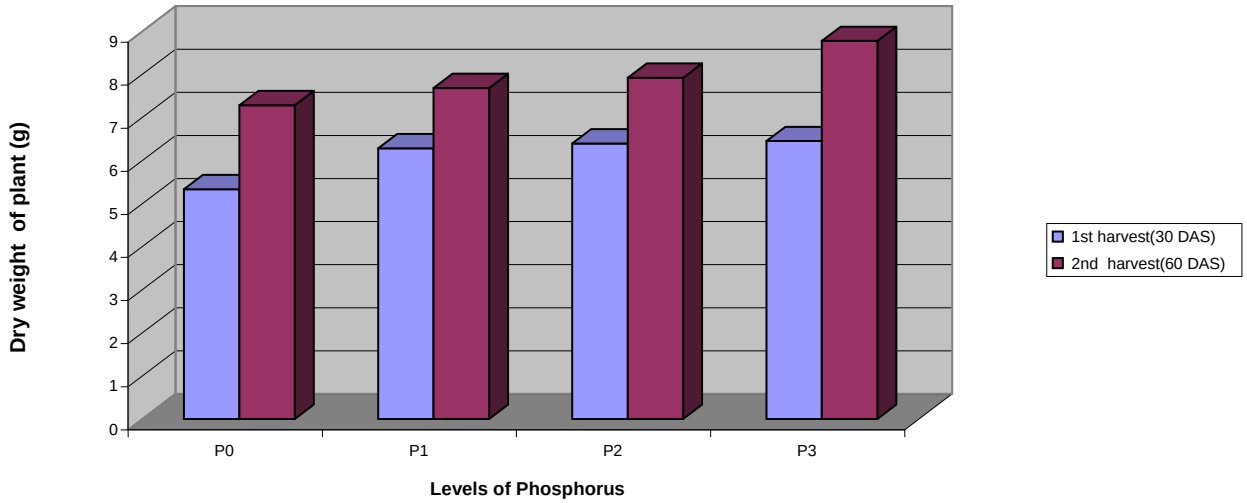


Fig: 3 . Main effect of phosphorus on the Dry weight of Plant (g) at different days aftr sowing

P_0 = Control

P_1 = 65 kg P_2O_5/ ha

P_2 = 75 kg P_2O_5/ ha

P_3 = 85 kg P_2O_5/ ha

Table 13. Combined effect of nitrogen and phosphorus on the Dry weight (g) of plant at different days after sowing

Treatment Combinations	1st harvest(30 DAS)	2nd harvest(60 DAS)
N_0P_0	5.20	6.36
N_0P_1	6.63	8.23
N_0P_2	6.00	8.66
N_0P_3	5.36	6.86
N_1P_0	5.70	7.73
N_1P_1	6.63	8.26
N_1P_2	6.40	8.50
N_1P_3	5.40	7.90
N_2P_0	5.40	8.36
N_2P_1	7.10	7.86

N_2P_2	6.30	8.76
N_2P_3	5.16	5.86
N_3P_0	5.90	8.23
N_3P_1	5.96	7.36
N_3P_2	6.50	8.46
N_3P_3	7.56	9.20
LSD (0.05)	0.67	0.66
Levels of significant	*	**

**Significant at 1% level
* Significant at 5% level
N_0 = Control
N_1 = 50 kg N /ha
N_2= 75 kg N /ha
N_3=100 kg N/ha

P_0 = Control
P_1 = 65 kg P_2O_5 /ha
P_2 = 75 kg P_2O_5 /ha
P_3 = 85 kg P_2O_5/ha

4.6 Effect of nitrogen and phosphorus on yield per plot (g)

The different level of nitrogen application influenced on the yield/plot of Gimakalmi (Fig 4). At first harvest (30 DAS) the maximum (650.83 g) was obtained from N_3 treatment and the minimum (578.33 g) was obtained form control treatment (N_O). At 60 DAS the yield range of the present study varied from 1291.66 to 1000.00 (g). The maximum yield (1291.66 g)

was observed from N_3 treatment and the lowest (1000.00 g) was recorded from the control treatment (N_0). The possible reason for such yield due to increase in the nitrogen level because nitrogen posses the vegetative growth which resulting the better yield.

The yield of gimakalmi per plot was found to be statistically significant due to different level of P_2O_5 (Fig 5). At first harvest (30 DAS) the maximum (650 g) yield per plot was obtained from P_3 treatment and the minimum (590.00 g) yield per plot was obtained from control treatment (P_o). At 60 DAS the highest (1190.33 g) yield was obtained from P_3 treatment and the lowest 1091.66 (g) was obtained from the control treatment (P_0).

The interaction effect of nitrogen and phosphorus exerted significant influence on yield per plot (Appendix iii). At first harvest (30 DAS) the maximum (760.33g) yield per plot was obtained from N_3P_3 treatment and the minimum (500.00 g) was obtained from N_oP_o treatment combination. At 60 DAS (2nd harvest) the range of yield contributed from 1350.23 g to 916.66 g. The highest gross yield (1350.23 g) obtained from N_3P_3 which was statistically similar with other treatments. The lowest yield (916.66 g.) was obtained from N_0P_0 treatment combination. Although the treatment N_3P_3 produced the highest gross yield but the treatment N_2P_3 and N_3P_2 gave the statistically same yield with higher dose. So the treatment N_3P_2 was considered to be the best treatment combination of nitrogen and phosphorus for maximizing yield per plot of gimakalmi (Table 14). This findings support the result of Sajjan et al (1991) in lettuce.

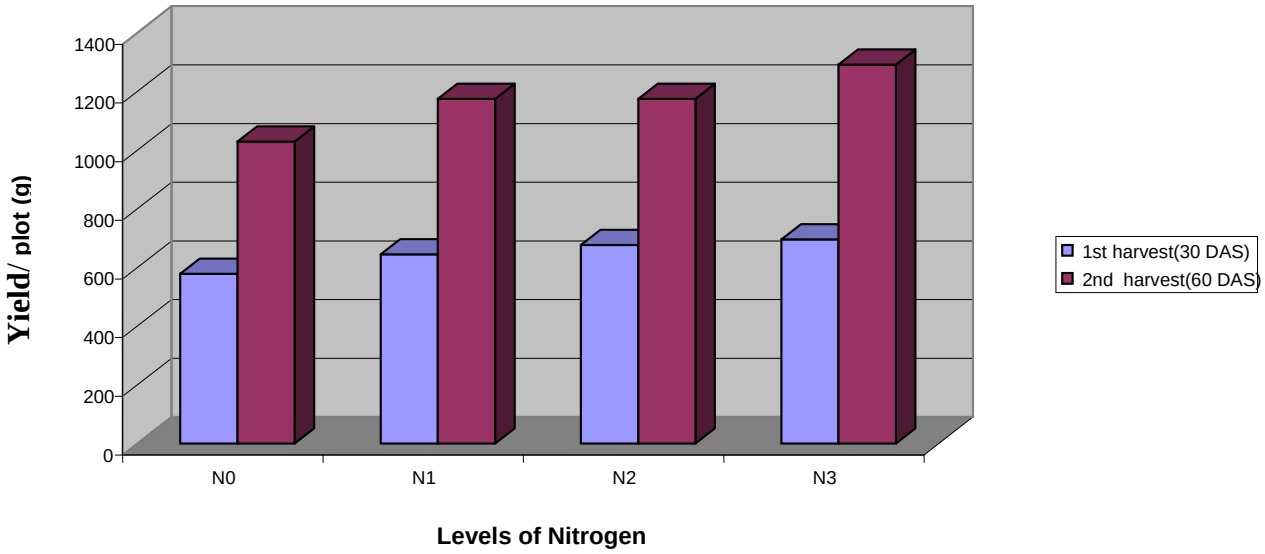


Fig. 4. Main effect of nitrogen on yield per plot (g) at different days after sowing

N_0 = Control

N_1 = 50 kg N/ha

N_2 = 75 kg N/ha

N_3 = 100 kg N/ha

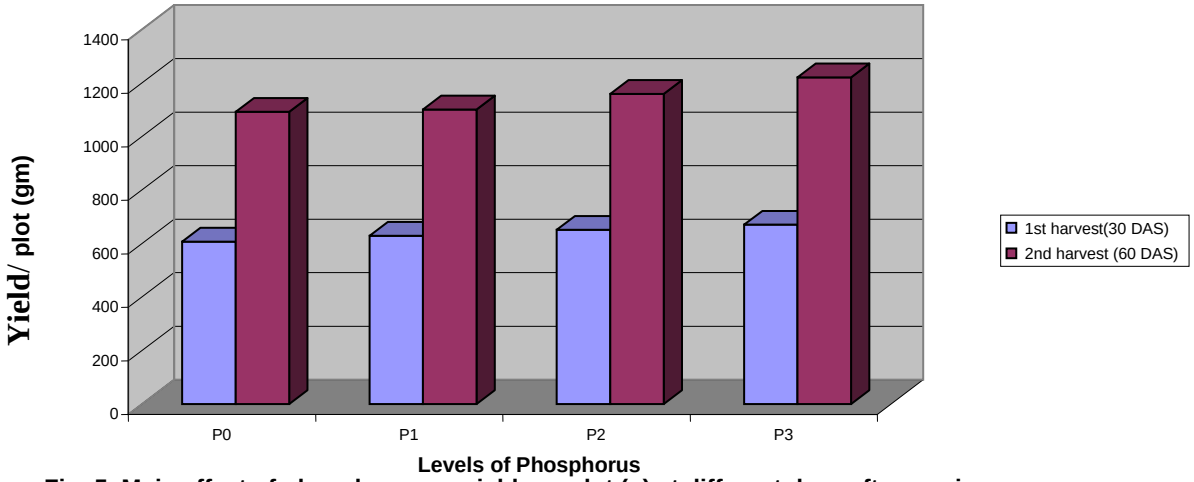


Fig: 5. Main effect of phosphorus on yield per plot (g) at different days after sowing

P_0 = Control

P_1 = 65 kg P_2O_5/ ha

P_2 = 75 kg P_2O_5/ha

P_3 = 85 kg P_2O_5/ ha

Table 14. Combined effect of nitrogen and phosphorus on yield per plot (g) at different days after sowing

Treatment Combinations	1^{st} harvest(30 DAS)	2^{nd} harvest(60 DAS)
N_0P_0	500.00	916.66
N_0P_1	616.66	983.33
N_0P_2	586.66	1050.00
N_0P_3	610.00	1166.66
N_1P_0	630.00	1150.00
N_1P_1	630.00	1150.00
N_1P_2	633.33	1100.00
N_1P_3	686.66	1300.00
N_2P_0	623.33	1300.00

N_2P_1	583.33	1100.00
N_2P_2	750.00	1200.00
N_2P_3	750.00	1316.00
N_3P_0	673.33	1166.66
N_3P_1	683.33	1283.33
N_3P_2	633.33	1316.66
N_3P_3	760.33	1350.23
LSD (0.05)	67.22	102.00
Levels of significant	*	*

**Significant at 1% level
* Significant at 5% level
N_0 = Control
N_1 = 50 kg N/ha
N_2= 75 N /ha
N_3= 100 kg N/ha

P_0 = Control
P_1 = 65 kg P_2O_5/ha
P_2 = 75 kg P_2O_5/ha
P_3 = 85 kg P_2O_5/ha

4.7 Effect of nitrogen and Phosphorus on yield per hectare(t)

The different level of nitrogen application influenced on the yield per ha (t) of gimakalmi (Fig.6). At first harvest (30 DAS) the maximum yield per ha (43.08 t/ha) was observed from N_3 treatment and the minimum yield per ha (41.00 t/ha)

was observed in control treatment (N_0). At 60 DAS the yield range of the present study varied from 59.58 to 53.25 (t/ha), the maximum (59.58 t/ha) gross yield was observed from N_3 treatment which was identical with N_2 and N_1 treatment and the lowest (53.25 t/ha) was observed from the control treatment (N_0). The possible reason for such yield due to increase in the nitrogen level because nitrogen posses the vegetative growth which resulting the better yield.

The yield of gimakalmi per hectare was found to be statistically significant due to different level of phosphorus (Fig.7). At first harvest (30 DAS) the maximum (44.50 t/ha) yield was obtained from P_3 treatment and the minimum (42.20 t/ha) yield was obtained from P_O treatment. Then in 2nd harvest (60 DAS) the highest (58.41 t/ha) yield was obtained from P_3 treatment which was identical with P_2. The lowest (52.41 t/ha) yield was obtained from the control treatment (P_0).

The interaction effect of nitrogen and phosphorus exerted significant influence on yield per ha (t) (Appendix III). At first harvest (30 DAS) the maximum (48.91 t/ha) yield per hectare was obtained from N_3P_3 and the minimum (40.66 t/ha) yield per hectare was obtained from N_oP_o treatment combination. At 60 DAS the range of yield contributed from 62.66 to 55.00 (ton). The highest gross yield (62.66 t/ha) obtained from N_3P_3. and the lowest yield (55.00 t./ha) was obtained from N_0P_0 treatment combination. Although the treatment N_3P_3 produced the highest gross yield but the treatment N_2P_3 and N_3P_2 gave the statistically same yield with higher dose. So the treatment N_3P_2 was considered to be the best treatment combination of nitrogen and phosphorus for maximizing gross yield of gimakalmi (Table 15).

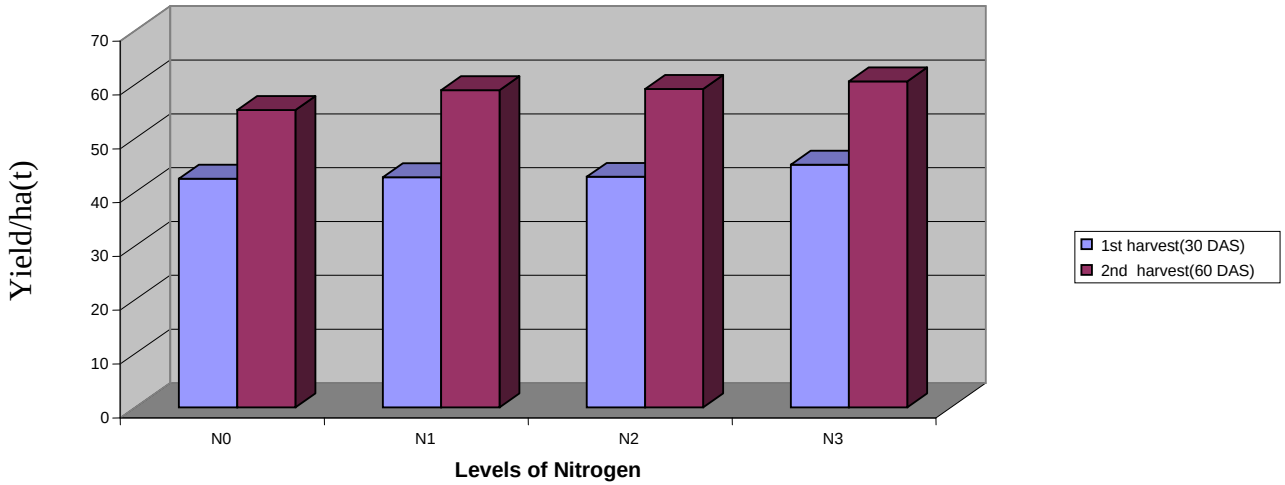


Fig: 6. Main effect of nitrogen on yield per hectare (t) at different days after sowing

N_0 = Control

N_1 = 50 kg N /ha

N_2 = 75 kg N /ha

N_3 = 100 kg N /ha

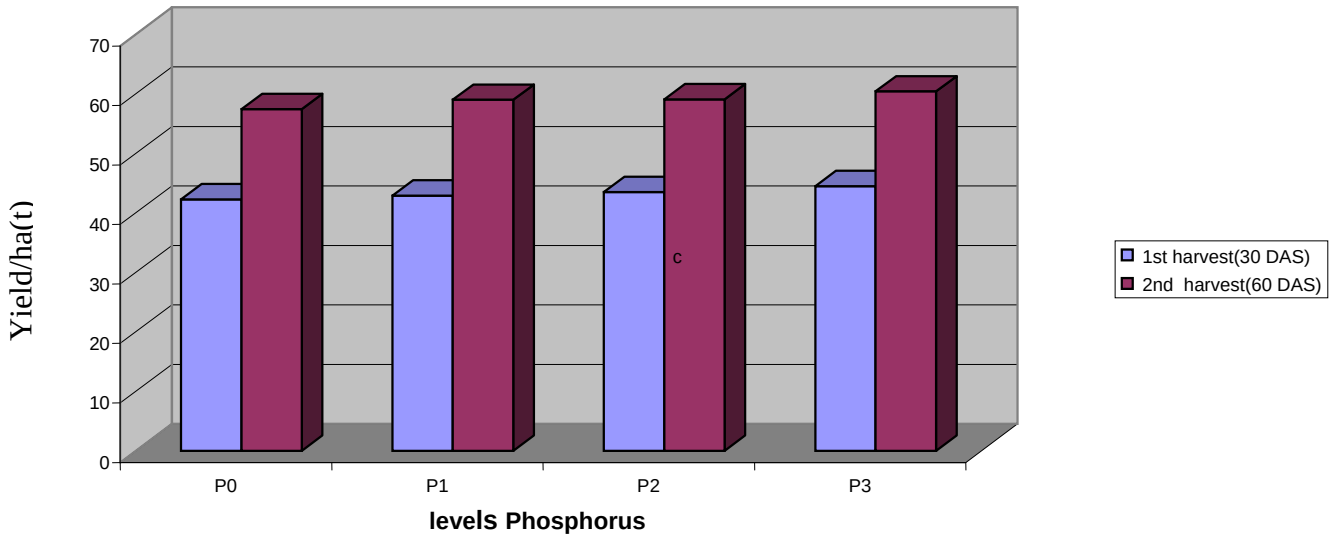


Fig: 7. Main effect of phosphorus on yield per hectare (t) at different days after sowing

P_0 = Control

P_1 = 65 kg P_2O_5/ha

P_2 = 75 kg P_2O_5/ha

P_3 = 85 kg P_2O_5/ha

Table 15. Combined effect of nitrogen and phosphorus on yield per hectare (t) at different days after sowing

Treatment Combinations	1st harvest(30 DAS)	2nd harvest(60 DAS)
N_0P_0	40.66	55.00
N_0P_1	41.33	60.00
N_0P_2	45.00	61.33
N_0P_3	44.00	57.00
N_1P_0	43.33	55.01
N_1P_1	42.00	53.33
N_1P_2	41.33	55.66
N_1P_3	42.66	55.00
N_2P_0	43.33	56.33
N_2P_1	43.33	60.00
N_2P_2	43.00	59.33
N_2P_3	44.33	60.00

N_3P_0	47.66	59.00
N_3P_1	45.33	60.66
N_3P_2	47.23	60.00
N_3P_3	48.91	62.66
LSD (0.05)	3.64	5.694
Levels of significant	*	**

**Significant at 1% level
* Significant at 5% level
N_0 = Control
N_1 = 50 kg N /ha
N_2= 75 kg N /ha
N_3= 100 kg N/ha

P_0 = Control
P_1 = 65 kg P_2O_5/ha
P_2 = 75 kg P_2O_5 /ha
P_3 = 85 kg P_2O_5/ha

4.8 Cost and return analysis

The cost and return analysis were done and have been presented in table 16 and appendix IV. Materials (1A), non materials (IB) and over head costs were recorded at 60 DAS for all the treatments of unit plot and calculated on per hectare basis the price of Gimakalmi at the local market rate were considered.

The total cost of production ranges between Tk. 72,440 to 74,652 per hectare among the different treatment combinations. The variation was due to different cost of fertilizer. The highest cost of production Tk. 74,652 per ha was involved in the treatment combination of N_3P_3 while the lowest cost of production Tk 72440 per ha was involved in the combination N_0P_0

(Appendix IV). Gross returns from the different treatment combinations range between Tk 2,22,500 and Tk. 1,55,000 per hectare.

Among the different treatment combinations N_3P_3 gave the highest net return Tk. 1,48,508 per hectare while the lowest net return Tk. 82,144 was obtained from the treatment combination of N_0P_0 (Control).

The benefit cost ratio (BCR) was found to be the highest (3.00) in the treatment combination of N_3P_3 and the lowest BCR (2.13) was recorded from N_0P_0 (Control treatment).

Table 16. Cost and return of Gimakalmi due to nitrogen and phosphorus

Treatment combinations	Gross yield (t/ha) 60 DAS	Gross return (Tt/ha)	Total cost of production (Tk/ha)	Net return (Tk/ha)	Benefit cost ratio (BCR)
N_0p_0	55	155000	72440	82144	2.13
N_0P_1	60	157500	72892	84608	2.16
N_0P_2	61	165000	73772	91228	2.24
N_0P_3	57	177500	73332	105060	2.45
N_1P_0	55	186500	72856	113168	2.54
N_1P_1	53	191500	74212	117288	2.58
N_1P_2	55	195000	72882	122118	2.68
N_1P_3	55	205800	73772	132028	2.79
N_2P_0	56	214000	73992	139348	2.87
N_2P_1	60	212500	73332	139168	2.90
N_2P_2	59	217500	74212	143288	2.93
N_2P_3	60	218800	74232	138900	2.80
N_3P_0	59	219900	73772	142508	2.94
N_3P_1	60	212500	74212	139268	2.97
N_3P_2	60	220000	73772	139288	2.86

N_3P_3	62	222500	74652	148508	3.00

N_0 =Control

N_1 = 50 kg N/ha P_0 = Control

N_2 = 75 kg N/ha P_1= 65 kg P_2O_5/ha

N_3 = 100 kg. N/ha P_2= 75 kg P_2O_5/ha

P_3 = 85 kg P_2O_5/ha

Note : Sale @ Tk. 3000.00/t

Total income = Marketable yield (t/ha) x Tk. 3000.00

BCR = Gross return / Total cost of production.

RESULTS AND DISCUSSION

The experiment was conducted to investigate the effect of different levels of fertilizer, Nitrogen and P hosphorus on the growth and yield of Gimakalmi. The analyses of variances for different characters have been presented in appendices III and.1v Data of the different parameters analyzed statistically and the results have been presented in the Table ..1..... to 7..... and Figures ..2..... to...15..... The results of the present study have been presented and discussed in this chapter under the following headings.

4. Effects of nitrogen and phosphorus on growth and yield of Gimakalmi

4.1. Plant height

4.1.1 Main effect of nitrogen on plant height of Gimakalmi at different DAS

The level of nitrogen application had marked influence on plant height of gimakalmi at different stages of growth i.e. 15, 30 and 45 days after sowing. The plant height was found to be increased significantly with the increase significantly with the increase in nitrogen level up to 100 kg/ha kg per hectare (Fig 2.). During the period of plant growth the maximum plant height (74.167) was observed in N_3 treatment where 100 kg N was applied at 45 days after sowing which was not identical with N_1 and N_2 treatments. In general, plant eight increased gradually in the early stages. The shortage plant height 37.083 (cm) was found in control plot (N_0).

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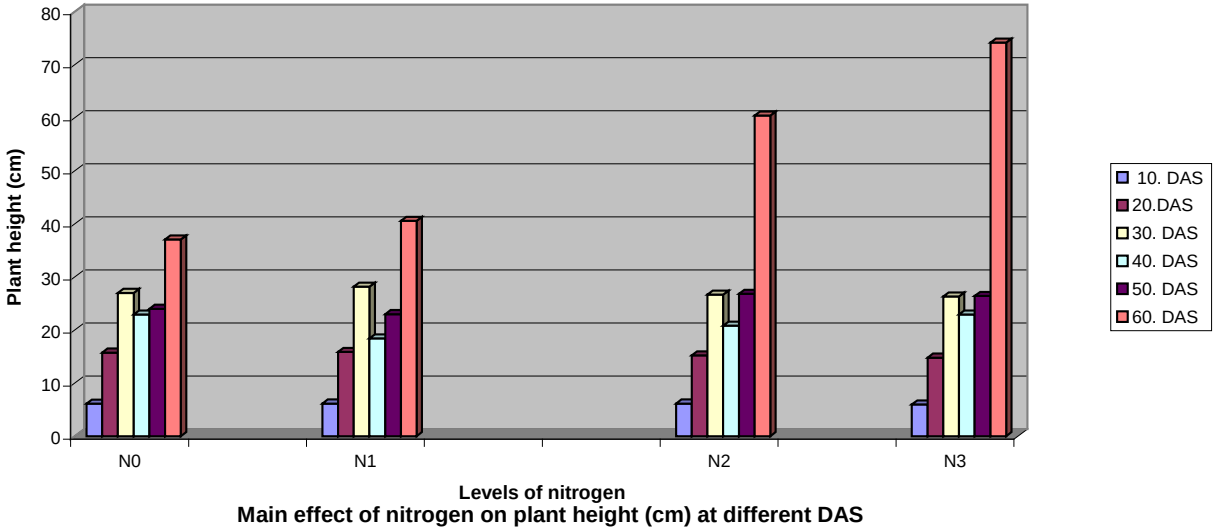


Main effect of nitrogen on plant height (cm) at different DAS

N_0 = Control

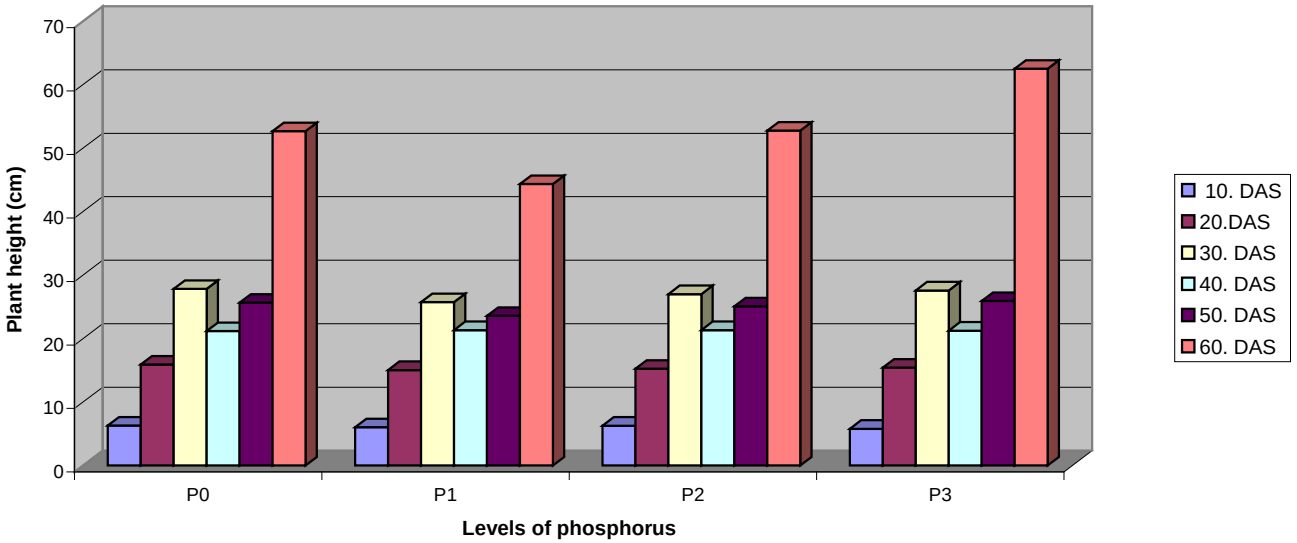
N_1 = Nitrogen 50 kg

N_2 = Nitrogen 75 kg

N_3 = Nitrogen 100 kg

4.1.2 Main effect of phosphorus on plant height of gimakalmi

The application of phosphorus influences the plant height of **g**imakalmi significantly. The longest plant height (62.5) was obtained from P_3 treatment which was followed by P_2 (52.75) and P_O (52.6) in descending order (Fig 3). The lowest plant height was found in P_0 (52.66.7). Application of phosphorus resulted the good root system which ultimately helps plant growth.



Main effect of phosphorus on plant height (cm) at different DAS

P_0	=	Control
P_1	=	Phosphorus 65 kg
P_2	=	Phosphorus 75 kg
P_3	=	Phosphorus 85 kg

4.1.3 Interaction effect of nitrogen and phosphorus on plant height of Gimakalmi

The plant height was significantly influenced by the interaction effect of nitrogen and phosphorus application on gimakalmi. The combined effect of fertilized N and P at different days after sowing was also significant (Appendix III.). The maximum vegetative growth was recorded at 60 DAS. The highest plat height of 83.833 was found from the N_3P_3 treatment combination and the lowest (32.333) from the control treatment (N_0P_0) at 60 DAS (Table 1).

Table 1. Combined effect of nitrogen & phosphorus on plant height at different DAS

Treatment Combinations	0. DAS	20.DAS	
$N_{0-}P_0$	.603	16.167	26.000
N_0P_1	.300	15.667	26.11
N_0P_2	.200	15.667	26.333
N_0P_3	.410	15.300	29.000

N_1P_0	**.233**	**1 4.607**	**26.667**
N_1P_1	**.567**	**1 5.833**	**27.000**
N_1P_2	**.367**	**1 5.333**	**26.333**
N_1P_3	**.433**	**1 5.167**	**26.000**
N_2P_0	**.767**	**1 5.500**	**26.333**
N_2P_1	**.633**	**1 5.000**	**24.000**
N_2P_2	**.000**	**1 4.833**	**28.333**
N_2P_3	**.333**	**1 5.500**	**28.000**
N_3P_0	**.000**	**1 5.667**	**27.667**
N_3P_1		**1**	**24.000**

	.567	**3.667**	
N_3P_2	**.733**	**1 6.000**	**29.667**
N_3P_3	**.817**	**1 6.333**	**31.333**
LSD 5%	**.839**	**3 .679**	**7.394**
Levels of significance	*****	*** ***	******

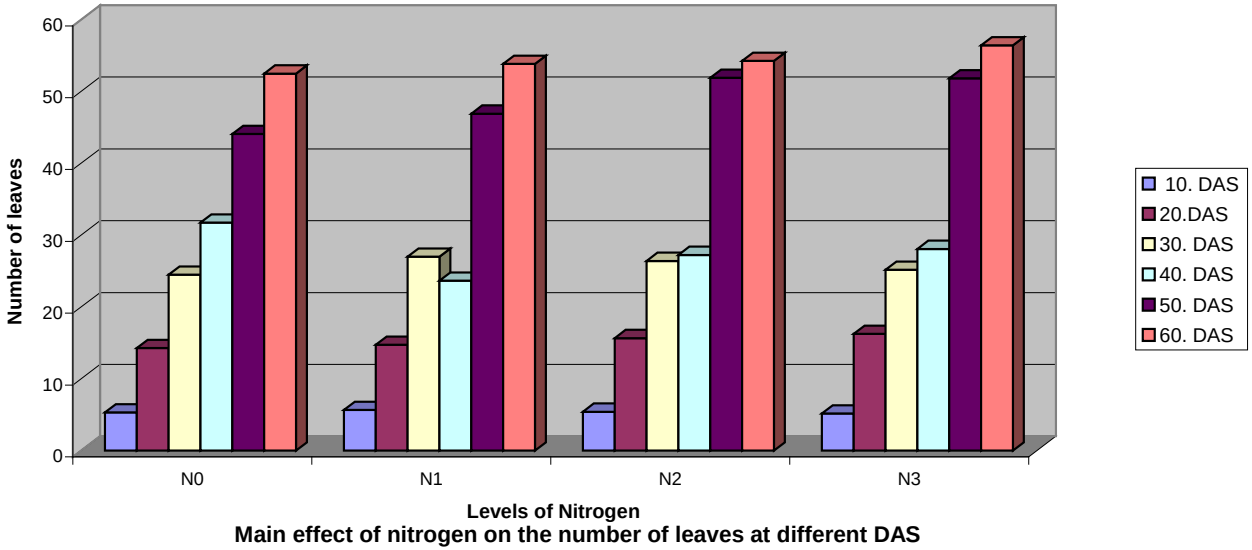
**Significance at 5% level
* Significance at 1% level
NS Non-significance
N_0 = Control
N = Nitrogen 50 kg/ha
N_2=Nitrogen 75 kg/ha
N_3=Nitrogen 100 kg/ha

P_0 = Control
P_1 = Phosphorus 65 kg/ha
P_2 = Phosphorus 75 kg/ha
P_3 = Phosphorus 85 kg/ha

4.2 Number of leaves per plant

4.2.1 Main effect of nitrogen on number of leaves of Gimakalmi

Application of nitrogen significantly increases the production of leaves per plant (Fig. 4) at different stages of sowing. The application of nitrogen of treatment N_3 resulted in the highest number of leaves (61.667) which was statistically identical with N_2 (54.25). The lowest (41.662) number of leaves found at N_0 treatment which was statistically different from N_1 (53.833). From the observation it was found that with increasing level of nitrogen application number of leaves increased. This results in agreement with that of Islam *et al. (1998)* in Batisak.



Main effect of nitrogen on the number of leaves at different DAS

N_0 = Control

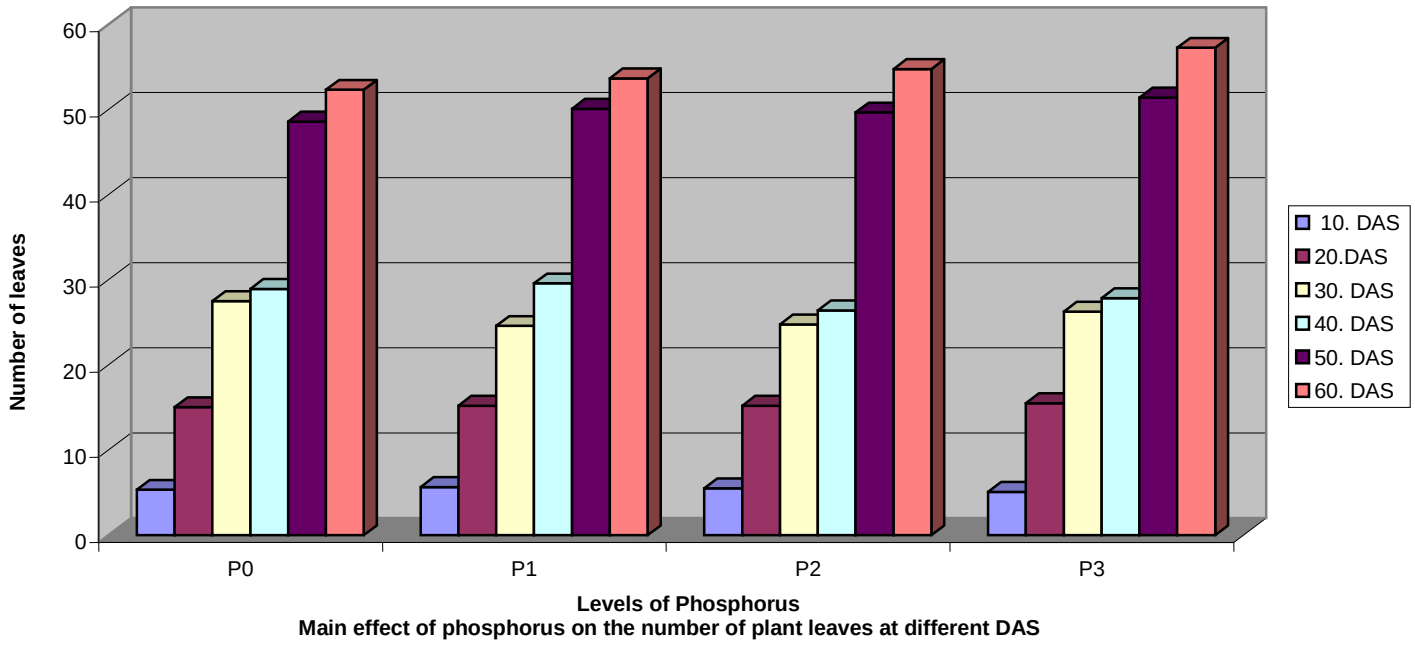
N_1 = Nitrogen 50 kg

N_2 = Nitrogen 75 kg

N_3 = Nitrogen 100 kg

4.2.2 Main effect of phosphorus on number of leaves of Gimakalmi.

Significant variation was found in case of production of leaves per plant due to the effect of phosphorus (Fig.5) at different DAS. 60DAS P_3 phosphorus treatment produced maximum number of leaves, followed by P_2 (54.75). The control treatment gave minimum number of leaves (48) per plant showing significantly different result from other treatments. Such response was possibly due to the physiochemical and biological improvement occurred in the soil including favorable temperature and moisture regimes, nutrient availability and microbial activity that moisture have provided.



Main effect of phosphorus on the number of plant leaves at different DAS

P_0 = Control

P_1 = Phosphorus 65 kg

P_2 = Phosphorus 75 kg

P_3 = Phosphorus 85 kg

4.2.3 Interaction effect of nitrogen and phosphorus on number of leaves of Gimakalmi.

The number of leaves per plant was also significantly influenced by the interaction effect of nitrogen and phosphorus (Appendix III). At 60DAS the plant receiving the treatment N_3P_3 produced the highest number of leaves (58). The lowest number of leaves (20) was observed from the control treatment, where no nitrogen and phosphorus were added (Table2).

Table 2. Combined effect nitrogen and phosphorus on number of leaves at different DAS

			20.000			

			24.333			
			23.667			
			27.000			

			54.667			
			20.000			
			23.000			

			26.333			
			20.333			
			24.000			

			25.667			
			26.667			
			26.630			

			20.000			
			29.000			
			30.000			

			2.628			
			**			

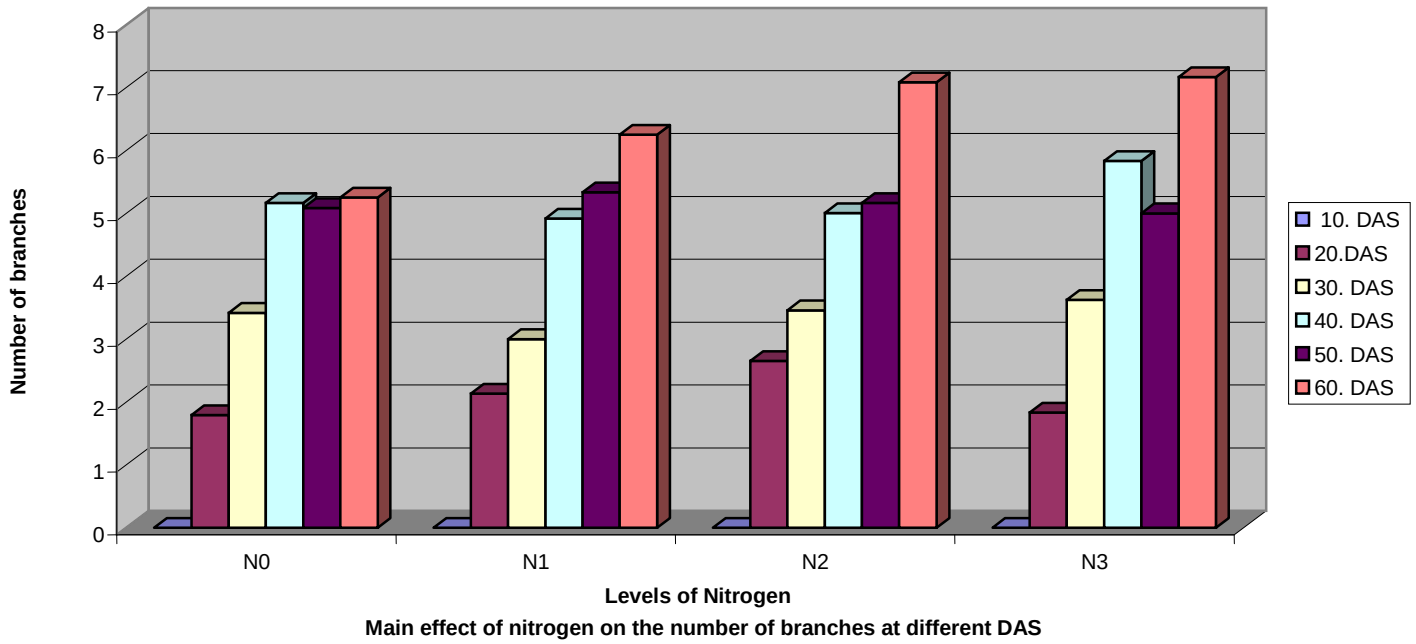
**Significance at 5% level
* Significance at 1% level
NS Non-significance
N_0 = Control
N = Nitrogen 50 kg/ha
N_2=Nitrogen 75 kg/ha
N_3=Nitrogen 100 kg/ha

P_0 = Control
P_1 = Phosphorus 65 kg/ha
P_2 = Phosphorus 75 kg/ha
P_3 = Phosphorus 85 kg/ha

4.3. Number of branches per plant

4.3.1Main effect of nitrogen on number of branches of Gimakalmi

Application of nitrogen significantly increases the production of branches per plant (.fig.…6....) at different stages of growing. The application of nitrogen that must N_3 resulted in the highest number of branches (7.167) which was statistically identical with N_2 (7.085). The lowest (5.25) number of branches found at N_0 treatment which was statistically different from N_2 (7.085). From the observation it was found that with increasing level of nitrogen application number of branches increased. This results in agreement with that of Islam et al (1988) in Batista This finding coincided with that of Islam *et al.* (1986), It shown that in 10 days after sowing no bronchus were produce.



Main effect of nitrogen on the number of branches at different DAS

N_0 = Control

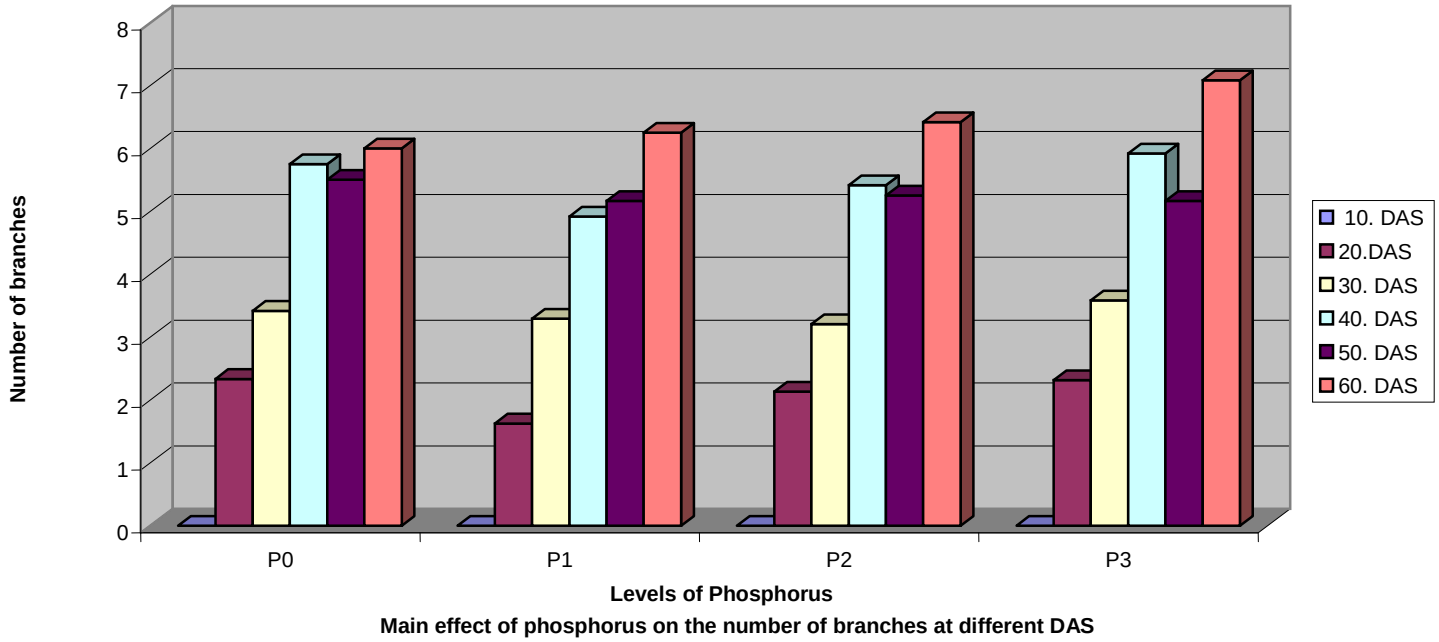
N_1 = Nitrogen 50 kg

N_2 = Nitrogen 75 kg

N_3 = Nitrogen 100 kg

4.3.2Main effect of phosphorus on number of branches.

Significant variation was found in production of branches per plant due to the effect of phosphorus (,fig,.….7....) at different DAS. It recorded that in 10 DAS no bandeaus were observed. At 60 DAS P_3 treatment Produce maximum (7.083) no of blanches followed by P_2 (6.417). The control treatment gave minimum number of branches (6) per plant showing significantly different result from other treatment. Such response was possibly due to the physical and biological improvement occurred in the Soil including favorable temperature, moisture nutrient availability & microtonal activity.



Main effect of phosphorus on the number of branches at different DAS

P_0 = Control

P_1 = Phosphorus 65 kg

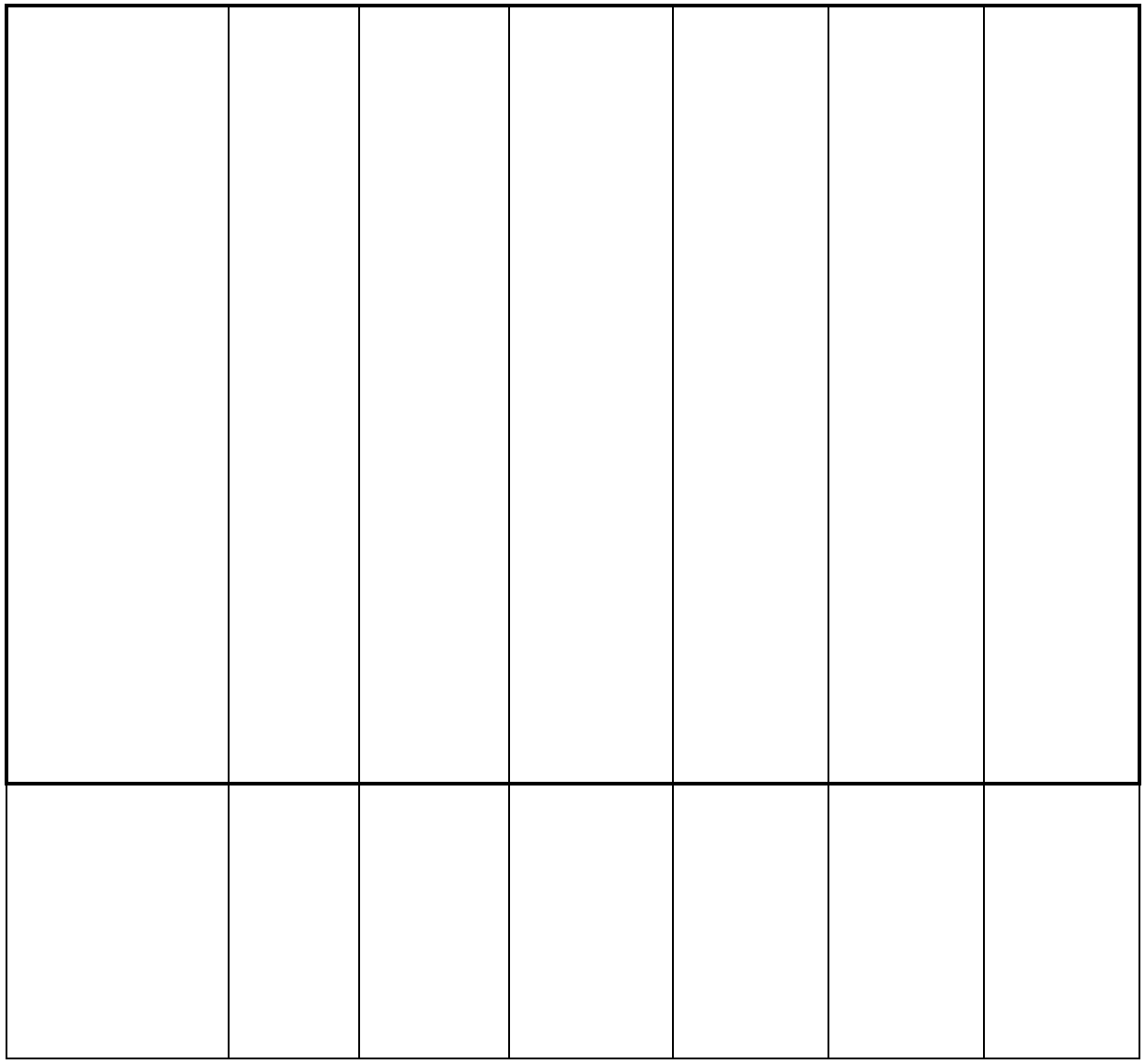
P_2 = Phosphorus 75 kg

P_3 = Phosphorus 85 kg

4.3.3Interaction effect of nitrogen and phosphorus on number of branches of gimakalmi.

The no. of branches per plant was also significantly influenced by the interaction effect of N and P (Appendix ..111.....). At 60 DAS the plant receive the treatment N_3P_3 Produced the highest number of branches (8.00). The lowest no of blanches (4.14) was observed form the control treatment where no nitrogen & p were added (Table..3.....).

Table 3. Combined effect of nitrogen and phosphorus on number of branches at different DAS



			0.338			
			****			

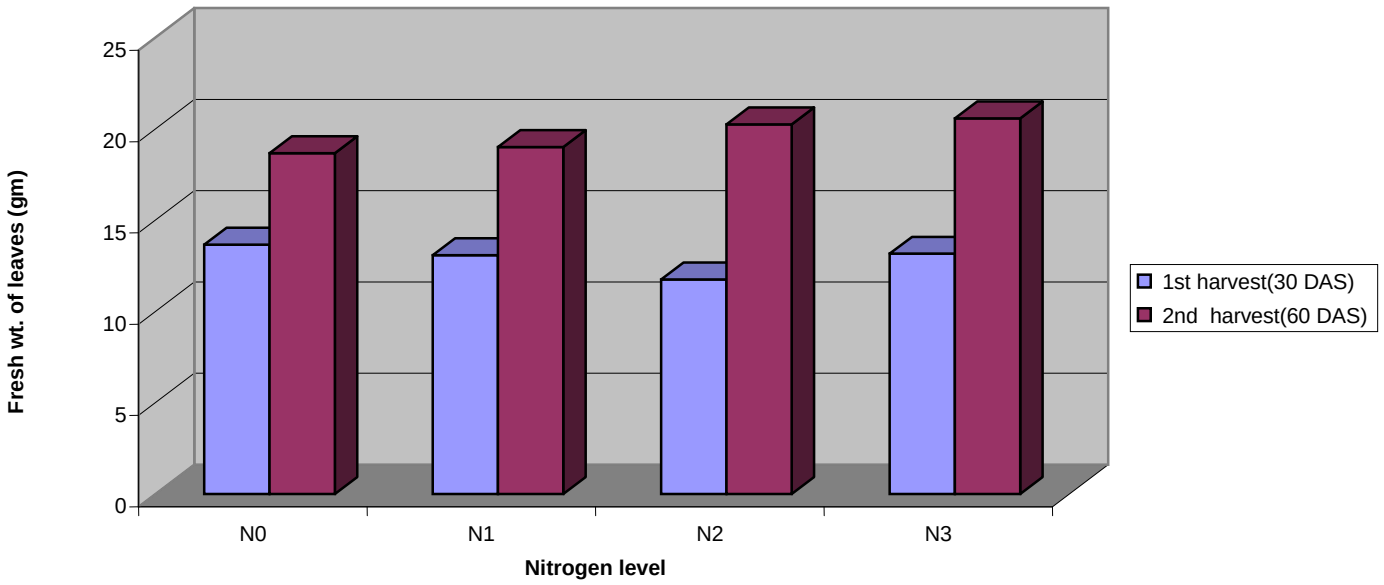
**Significance at 5% level
* Significance at 1% level
NS Non-significance
N_0 = Control
N = Nitrogen 50 kg/ha
N_2=Nitrogen 75 kg/ha
N_3=Nitrogen 100 kg/ha

P_0 = Control
P_1 = Phosphorus 65 kg/ha
P_2 = Phosphorus 75 kg/ha
P_3 = Phosphorus 85 kg/ha

4.4 Fresh wt. of leaf/plant

4.4.1 Main effect of nitrogen on fresh wt. of leaves of Gimakalmi

The fresh wt. of leaves varied form different level of nitrogen application in Gimakalmi (Fig.8). The maximum fresh weight of leaves per plant was contribute by N_3 treatment followed by N_2 (20.25) and N_1 (19). The plant receiving the treatment N_0 was the lowest in this respect. The present findings either partially or fully agree with the previous works of El-Hassan (1990); Anez and Pino (1997) and Kowalska (1997). Nitrogen promoter vegetative growth which ultimately increase the yield.

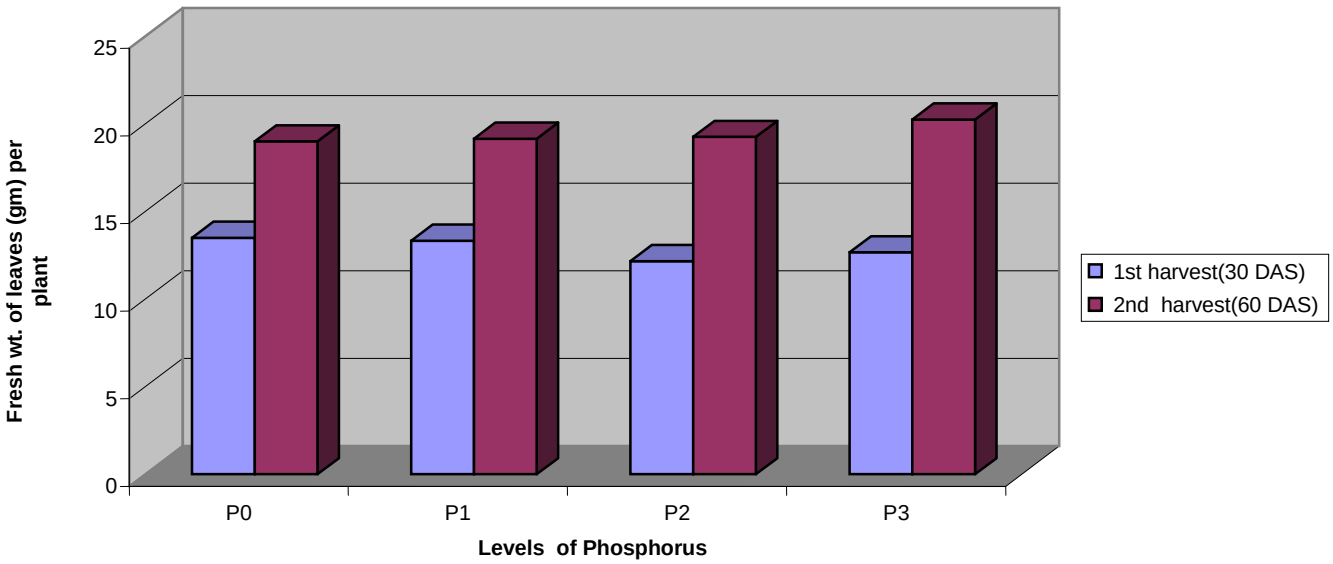


Main effect of nitrogen on the fresh wt. of leaves (gm) per plant at different DAS

N_0	=	Control
N_1	=	Nitrogen 50 kg
N_2	=	Nitrogen 75 kg
N_3	=	Nitrogen 100 kg

4.4.2 Main effect of phosphorus on fresh weight of leaves of Gimakalmi

Significantion variation was observed for fresh weight of leaves due to different level of phophorus application. Maximum wt. of fresh weight of leaves was found by P_3 which was not identical with P_2 treatment and the minimum wt. of leaf was found in P_0 treatment. The possible reason for such higher leaf yield with increasing phosphorus might be that the plants produced more carbohydrate through better photosynthesis (Ninmje and jagdich, 1987).



Main effect of phosphorus on the fresh wt. of leaves at different DAS

P_0 = Control

P_1 = Phosphorus 65 kg

P_2 = Phosphorus 75 kg

P_3 = Phosphorus 85 kg

4.4.3 Interaction effect of nitrogen and phosphorus on fresh weight of leaves of Gimakalmi

The significant interaction effect of nitrogen and phosphorus was observed on fresh weight of leaves per plant. The combined effect of nitrogen and phosphorus was also significant on fresh weight of leaves per plant. The maximum fresh weight of leaves (22.012 g.) was obtained from N_3P_3 treatment combination which was not statistically similar with other treatment. The lowest fresh weight of leaves (15.33 g.) was found in N_0P_0 treatment combination. The possible reason such higher fresh weight of leaves is that the uptake of phosphorus involved with enhanced photosynthesis resulting the increasing nitrogen uptake that also promote better yield. [Table—4]

Table 4. Combined effect of nitrogen and phosphorus on the fresh wt. of leaves at different DAS

	s t	2 nd harve st (60

	I **a** **r** **V** **e** **s** **t** **(** 3 **0** **I** A **s** **)**	**DAS)**
	0 **.** **0** **0** **0**	**1** **5.333**
		2

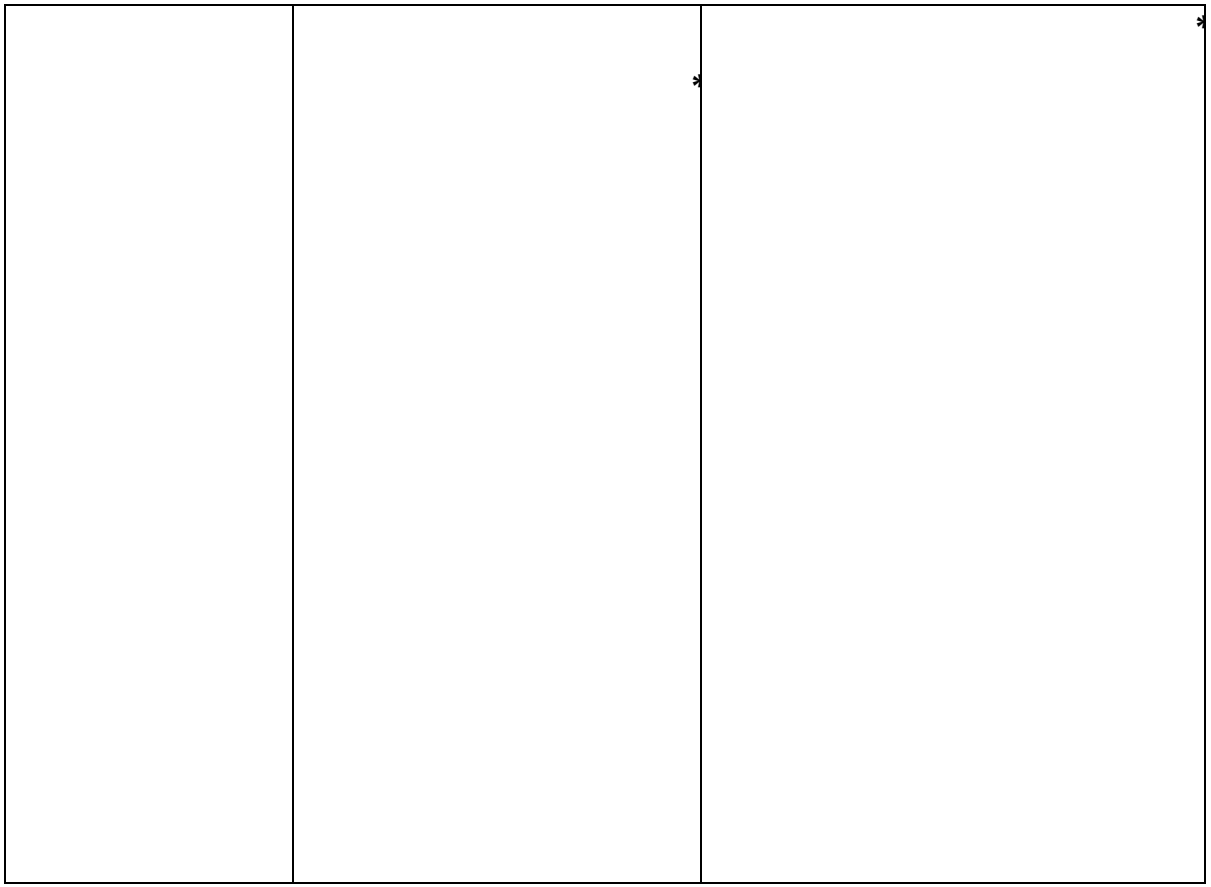
	3 . 0 0 0	**0.667**
	3 . 6 6 7	2 **1.667**
	5 . 0 0 0	2 **1.667**
	5	2 **1.020**

	. 0 0 0	
	3 . 3 3 3	1 8.667
	1 . 1 2 0	1 8.333
	0 .	1 8.667

	6 **6** **7**	
	2 **.** **0** **0** **0**	**1** **9.000**
	2 **.** **6** **6** **7**	**1** **8.383**
	3 **.** **0**	**2** **0.000**

	0 **0**	
	1 **.** **6** **6** **7**	**1** **8.667**
	4 **.** **0** **0** **0**	**2** **1.667**
	1 **.** **0** **0**	**1** **9.333**

		0.000
		2.012
		.973

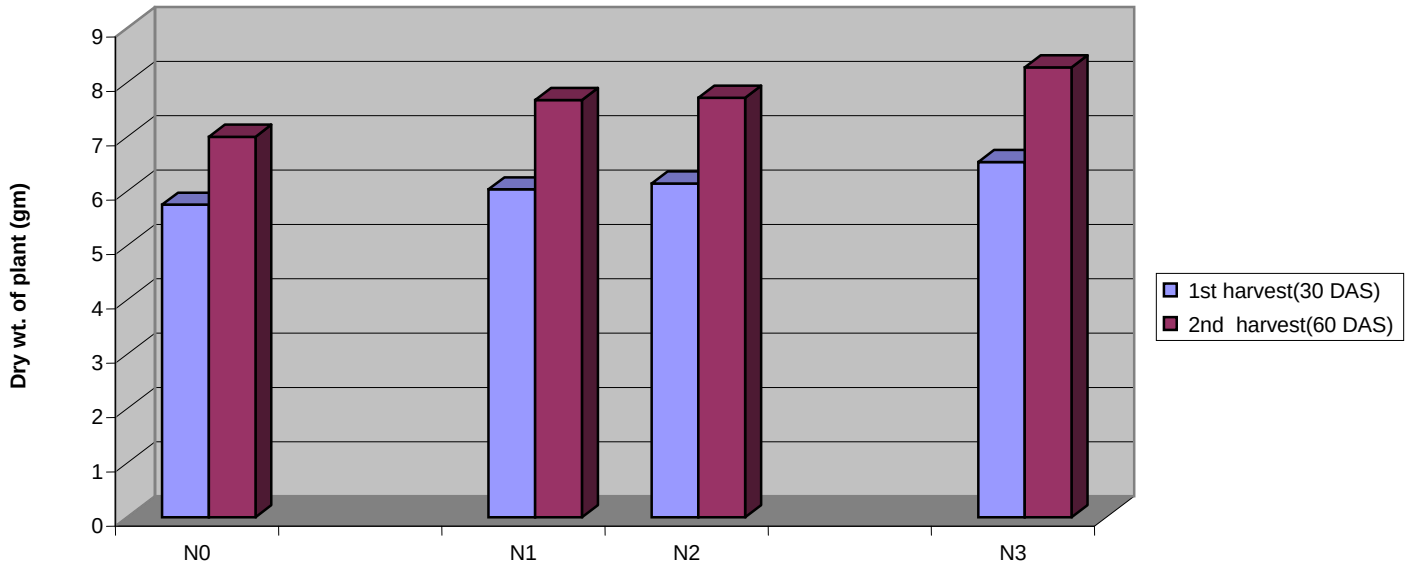


**Significance at 5% level
* Significance at 1% level
NS Non-significance
N_0 = Control
N = Nitrogen 50 kg/ha
N_2=Nitrogen 75 kg/ha
N_3=Nitrogen 100 kg/ha

P_0 = Control
P_1 = Phosphorus 65 kg/ha
P_2 = Phosphorus 75 kg/ha
P_3 = Phosphorus 85 kg/ha

4.5.1Main effect of nitrogen on the Dry wt. of plant (gm) at different DAS

The dry wt. of plant also varied significantly with different nitrogen levels. The dry wt. of plant was recorded to be the highest (8.275(gm) where N3 treatment was applied. The lowest dry wt. of plant (7.00 gm) was obtained farm the control treatment (No). [fig -10] The possible reason regarding high dry wt. of plant is that proper does of nitrogen uptake other nutrient in balance condition which accumulated more plant nutrient that gave more dry matter in plant.



Main effect of nitrogen on the Dry wt. of plant (gm) at different DAS

N_0 = Control

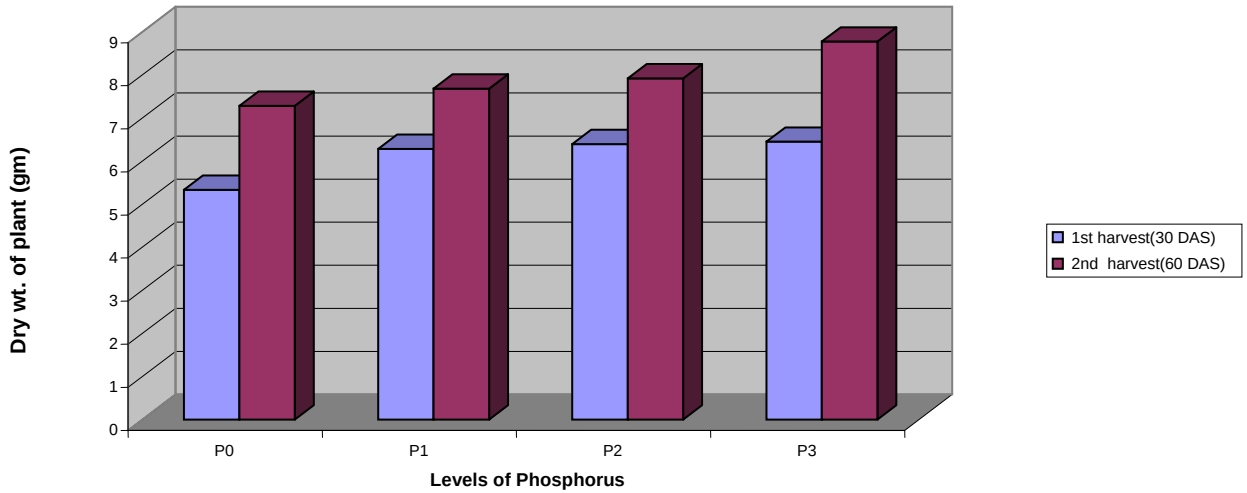
N_1 = Nitrogen 50 kg

N_2 = Nitrogen 75 kg

N_3 = Nitrogen 100 kg

4.5.2Main effect of phosphorus on the dry wt. of plant (gm) of different DAS.

Application of phosphorus showed significant influence on the dry wt. of plant in gima kolmi (Table-8) The maximum was found from P3 treatment followed by P2 treatment (7.92) the minimum (7.28 gm) in this respect was found from the control treatment (Po). [Fig---11]



Main effect of phosphorus on the Dry wt. of plant (gm) at different DAS

P_0 = Control

P_1 = Phosphorus 65 kg

P_2 = Phosphorus 75 kg

P_3 = Phosphorus 85 kg

-

4.5.3Combined effect of nitrogen and phosphorus on the Dry wt. of plant at different DAS.

Both the nitrogen and phosphorus effect were significant in respect of dry wt. of plant of gimakolmi. However, the maximum dry wt. of plant (9.20 gm) was observed in the treatment combination N_3P_3 treatment and the minimum dry wt. (6.36 gm) was recorded from the control t.reatment. [table---5]

Table 5. Combined effect of nitrogen and phosphorus on the Dry wt. of plant at different DAS

	s t **I** a **I** **V** e s t (5 0 **I** A s)	2 nd **harve st(60 DAS)**
		6

	. 2 0 0	.367
	. 6 53	8 .233
	. 0 0 0	8 .667
	. 53 6 1	6 .867

	.7	.733
	.6	.267
	.4	.500
	.4	.900

	0	
	.4000	.367
	.1000	.867
	.3000	.767
	.	.867

	1 6 7	
	. 9 0 0	8 .233
	. 9 6 7	7 .367
	. 5 0 0	8 .467
		9

	.	.200
	.	.669
		*

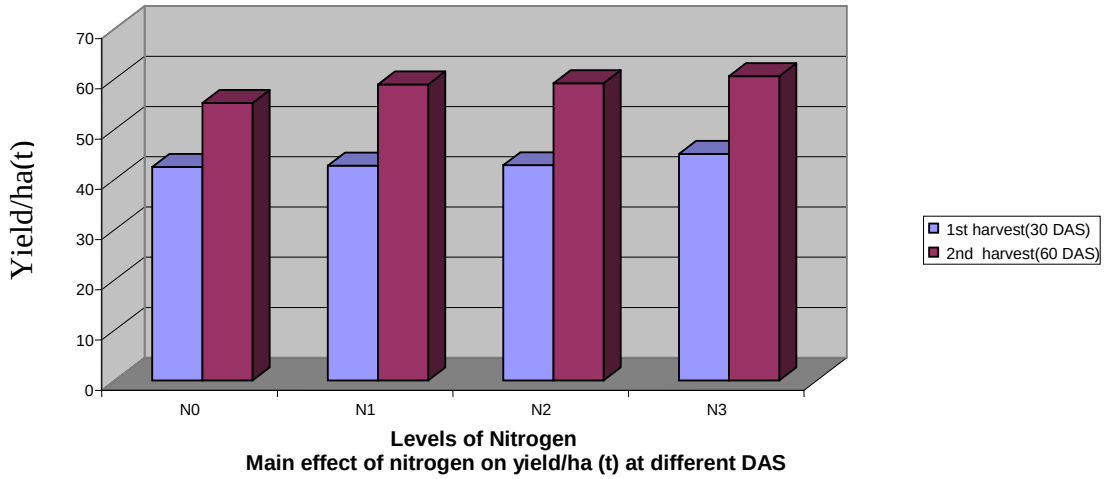
**Significance at 5% level
* Significance at 1% level
NS Non-significance
N_0 = Control
N = Nitrogen 50 kg/ha
N_2=Nitrogen 75 kg/ha
N_3=Nitrogen 100 kg/ha

P_0 = Control
P_1 = Phosphorus 65 kg/ha
P_2 = Phosphorus 75 kg/ha
P_3 = Phosphorus 85 kg/ha

4.6 Gross yield (t/ha)

4.6.1 Main effect of nitrogen on yield/ha (ton) of Gimakalmi

The different level of nitrogen application influenced on the yield (t/ha) of Gimakalmi (.fig---12 .....). The yield range of the present study varied from 60.583 to 55.25 t/ha. That maximum gross yield (60.583) was observed from N_3 treatment which was identical with N_2 and N_1 treatment and the lowest (55.25 t/ha) was observed from the control treatment (N_0). The possible reason for such yield due to increase in the nitrogen level because nitrogen posses the vegetative growth witch resulting the better yield. First harvest in 30 DAS yield/ha has (45.083 t/ha). Then in 2nd harvest in 60 DAS yield/ha was (60.583) respectively.



N_0 = Control

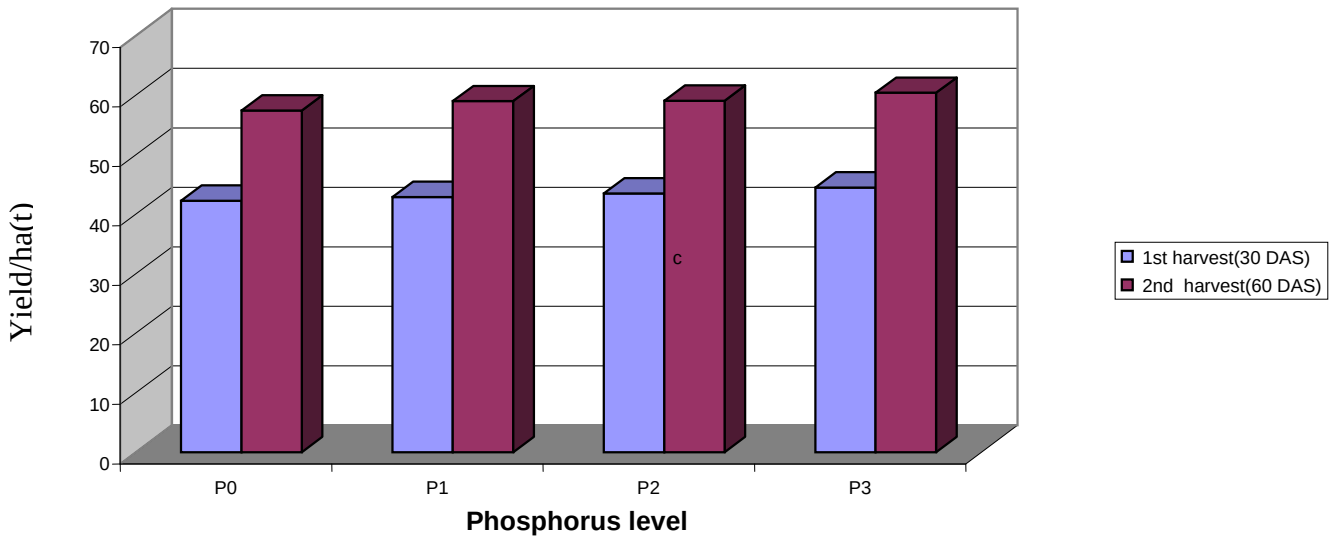
N_1 = Nitrogen 50 kg

N_2 = Nitrogen 75 kg

N_3 = Nitrogen 100 kg

4. 6.2 Main effect of phosphorus on yield/ha (ton) of Gimakalmi

The yield of gimakalmi per hectare was found to be statistically significant due to different level of phosphorus (. Fig---13.....). The highest (60.417) yield was obtained from P_3 treatment which was identical with P_2. The lowest (57.417) was obtained from the control treatment (P_0). First harvest in 30 DAS yield/ ha was (44.5 t/ha). Then in 2^{nd} harvest in 60 DAS yield/ha was (60.417) respectively.



Main effect of phosphorus on yield/ha(t) at different DAS

P_0 = Control

P_1 = Phosphorus 65 kg

P_2 = Phosphorus 75 kg

P_3 = Phosphorus 85 kg

4.6.3 Interaction effect of nitrogen and phosphorus on yield/ha (ton) of Gimakalmi.

The interaction effect of nitrogen and phosphorus exited significant influence on yield/ha (ton) yield/ha (Appendix ...III). The range of yield contributed from 62.66 to 55.00 (ton). The highest gross yield (62.66 t.) obtained from N_3P_3 which was statistically similar with other treatments. The lowest yield (55.00 t.) was obtained from N_0P_0 treatment combination. Although the treatment N_2P_3 produced the highest gross yield but the treatment N_3P_2 was considered to be the best treatment combination of nitrogen and phosphorus for maximizing leaf yield of (Table..6). This findings support the result of Sajjan et al (1991).

Table 6. Combined effect of nitrogen and phosphorus on yield/ha (ton) at different DAS

	s t **harve st(60 DAS)**	**nd**
	5.000	

		0.000
		1.333
		7.000
		5.012

	2 . 0 0 0	3.333
	1 .	5.667
	2 . 6 6 7	5.000
	3 .	6.333
	3 .	6 0.000

		9.333
		0.000
		9.000
		0.667

	7 . 4 5	**0.000**
	8 . 9 1 2	**6 2.667**
	. 6 4 2	**5 .694**
		*** ***

**Significance at 5% level
* Significance at 1% level
NS Non-significance
N_0 = Control
N = Nitrogen 50 kg/ha
N_2=Nitrogen 75 kg/ha
N_3=Nitrogen 100 kg/ha

P_0 = Control
P_1 = Phosphorus 65 kg/ha
P_2 = Phosphorus 75 kg/ha
P_3 = Phosphorus 85 kg/ha

4.7.1. Main effect of nitrogen on yield/plot (g) of Gima kalmi

The different level of nitrogen application influenced on the yield/plot of Gima kalmi (.Fig.---14). The yield range of the present study varied from 1291.667 to 1029.167 (g). That maximum gross yield (61291.667) was observed from N_3 treatment which was identical with N_2 and N_1 treatment and the lowest (1029.167(g)/plot was observed from the control treatment (N_0). The possible reason for such yield due to increase in the nitrogen level because nitrogen

posses the vegetative growth witch resulting the better yield. First harvest in 30 DAS yield/plot ha has (44.5 t/ha). Then in 2nd harvest in 60 DAS yield/plot ha was (60.417) respectively.

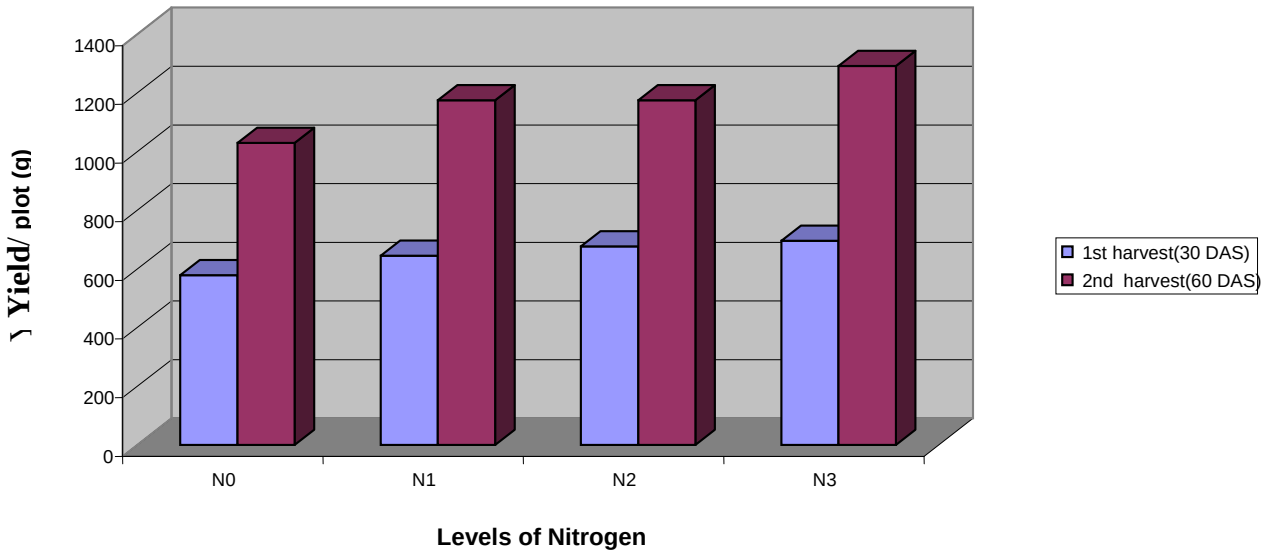


Fig. 14. Main effect of nitrogen on yield/plot (g) at different DAS

N_0 = Control

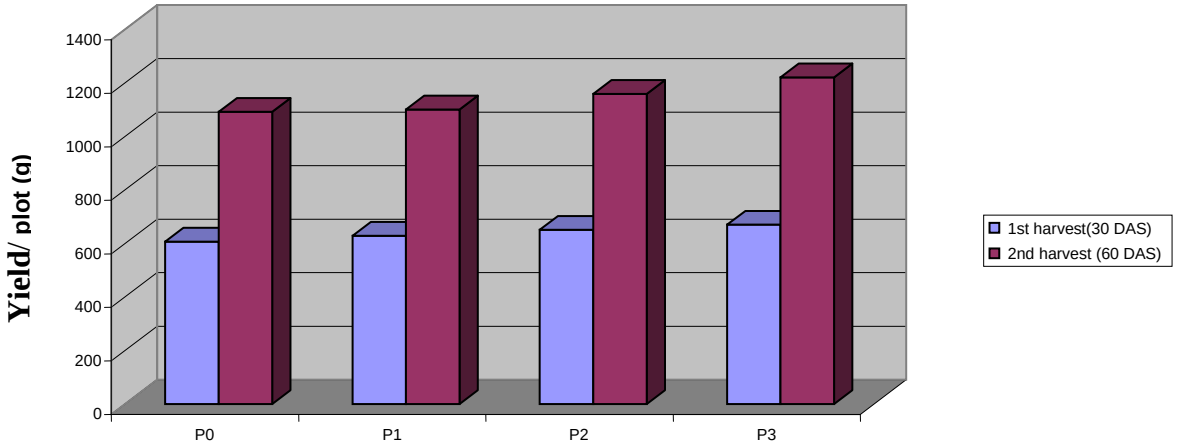
N_1 = Nitrogen 50 kg

N_2 = Nitrogen 75 kg

N_3=Nitrogen 100 kg

Main effect of phosphorus on yield/plot of Gimakalmi

The yield of gimakalmi per hectare was found to be statistically significant due to different level of phosphorus (.....). The highest (1220.333) yield was obtained from P_3 treatment which was identical with P_2. The lowest 1091.667(g)) was obtained from the control treatment (P_0). First harvest in 30 DAS yield/ plot has 670 (g). Then in 2^{nd} harvest in 60 DAS yield/plot was 1220.333(g) respectively.



Main effect of phosphorus on yield/plot (g) at different DAS

P_0 = Control

P_1 = Phosphorus 65 kg

P_2 = Phosphorus 75 kg

P_3 = Phosphorus 85 kg

Interaction effect of nitrogen and phosphorus on yield/plot of Gimakalmi.

The interaction effect of nitrogen and phosphorus exited significant influence on yield/plot (Appendix .....). The range of yield contributed from 1291.667 to 1029.167gm.. The highest gross yield (1291.66 gm) obtained from N_3 P_3 which was statistically similar with other treatments. The lowest yield (1029.16 gm.) was obtained from N_0P_0 treatment combination. Although the treatment N_2P_3 produced the highest gross yield but the treatment N_3P_2 was considered to be the best treatment combination of nitrogen and phosphorus for maximizing leaf yield of (Table .....). This findings support the result of Sajjan et al (1991).

Table 7. Combined effect of nitrogen and phosphorus on yield/plot(g) at different DAS

		2nd harvest(60 DAS)
		16.667

		$ 83.333
		1 050.000
		1 166.667
		1 150.000

		1 150.0 00
		1 100.0 00
		1 300.0 00
		1 300.0 00

		1 **100.0** **00**
		1 **200.0** **00**
		1 **100.0** **00**
		1 **166.6** **67**

		1283.333
		1316.667
		1350.231
		102.00

**Significance at 5% level
* Significance at 1% level
NS Non-significance
N_0 = Control
N = Nitrogen 50 kg/ha
N_2=Nitrogen 75 kg/ha
N_3=Nitrogen 100 kg/ha

P_0 = Control
P_1 = Phosphorus 65 kg/ha
P_2 = Phosphorus 75 kg/ha
P_3 = Phosphorus 85 kg/ha

Cost and return analysis

The cost and return analysis were done and have been presented in table 8 and appendix IV. Materials (1A), non materials (IB) and over head costs were recorded for all the treatments of unit plot and calculated on per hectare basis the price of Gimakalmi at the local market rate were considered.

The total cost of production ranges between Tk. 72440 to 74652 per hectare among the different treatment combinations. The variation was due to different cost of fertilizer. The highest cost of production Tk. 74652 per ha was involved in the treatment combination of N_3P_3 while the lowest cost of production Tk 72440 per ha was involved in the combination N_1P_0 (Appendix IV). Gross returns from the different treatment combinations range between Tk 222500 and Tk. 155000 per ha.

Among the different treatment combinations N_3P_3 gave the highest net return Tk. 148508 per ha while the lowest net return Tk. 82144 was obtained from the treatment combination of N_0P_0.

The benefit cost ratio (BCR) was found to be the highest (3.0) in the treatment combination of N_3P_3. The lowest BCR (2.13) was recorded from the combination of N_0P_0

Table 8. Cost and return of Gimakalmi due to nitrogen and phosphorus

Treatment combinations	Gross yield (t/ha) 60 DAS	Gross return (Tt/ha)	Total cost of production (Tk/ha)	Net return (Tk/ha)	Benefit cost ratio (BCR)
N_0p_0	55	155000	72856	82144	2.13
N_0P_1	60	157500	72892	84608	2.16
N_0P_2	61	165000	73772	91228	2.24
N_0P_3	57	177500	73332	105060	2.45
N_1P_0	55	186500	72440	113168	2.54
N_1P_1	53	191500	74212	117288	2.58
N_1P_2	55	195000	72882	122118	2.68
N_1P_3	55	205800	73772	132028	2.79
N_2P_0	56	214000	73992	139348	2.87
N_2P_1	60	212500	73332	139168	2.90
N_2P_2	59	217500	74212	143288	2.93
N_2P_3	60	218800	74652	138900	2.80
N_3P_0	59	219900	73772	142508	2.94
N_3P_1	60	212500	74212	139268	2.97
N_3P_2	60	220000	73772	139288	2.86

N_3P_3	62	222500	74232	148508	3.00

N_0 =Control

N_1 = Nitrogen 50 kg P_0 = Control

N_2 = Nitrogen 75 kg P_1= Phosphorous 65 kg

N_3 = Nitrogen 100 kg P_2= Phosphorous 75 kg

P_3 =Phosphorous 85

Note : Sale @ Tk. 5000.00/t

Total income = Marketable yield (t/ha) x Tk. 5000.00

BCR = Gross return / Total cost of production.

Appendix IV. Production cost of GimaKalmi per hectare

(A) Meterial cost (Tk.)

Treatment combinations	Seed (Kg/ha)	Fertilizer and manure				Irrigation	Sub total 1(A)
		Cowdung	Urea	TSP	Mp		
N_0P_0	8000	6000	-	-	1120	1500	16620
N_0P_1	8000	6000	-	400	1120	1500	17020
N_0P_2	8000	6000	-	800	1120	1500	17420
N_0 P_3	8000	6000	-	1600	1120	1500	18220
N_1P_0	8000	6000	400	-	1120	1500	17020

N_1P_1	8000	6000	400	400	1120	1500	17420
N_1P_2	8000	6000	400	800	1120	1500	18220
N_1P_3	8000	6000	400	1600	1120	1500	18110
N_2P_0	8000	6000	800	-	1120	1500	17880
N_2P_1	8000	6000	800	400	1120	1500	17820
N_2P_2	8000	6000	800	800	1120	1500	18420
N_2P_3	8000	6000	800	1600	1120	1500	18620
N_3P_0	8000	6000	1200	-	1120	1500	18810
N_3P_1	8000	6000	1200	400	1120	1500	18990
N_3P_2	8000	6000	1200	800	1120	1500	19100
N_3P_3	8000	6000	1200	1600	1120	1500	19420

Seed @ Tk. 8000 /Kg

Cowdung @ Tk. 600/ ton.

Urea @ Tk. 8 /kg.

TSP @ Tk. 16/kg

Appendix IV. Contd.

(B) Non-material cost (Tl./ha)

Treatment combination	Land Preparation	Fertilizer and manure application	Seed sowing and bed preparation	Intercultural operation	Harvesting	Sub total	Total input cost 1(A) + 1(B)
N_0P_0	10500	1050	5250	10000	7500	33250	49870
N_0P_1	10500	1050	5250	10000	7500	34300	51720
N_0P_2	10500	1050	5250	10000	7500	34300	52520
$N_0\ P_3$	10500	1050	5250	10000	7500	34300	51320
N_1P_0	10500	1050	5250	10000	7500	34300	52120
N_1P_1	10500	1050	5250	10000	7500	34300	52920
N_1P_2	10500	1050	5250	10000	7500	34300	51720
N_1P_3	10500	1050	5250	10000	7500	34300	52520
N_2P_0	10500	1050	5250	10000	7500	34300	53320
N_2P_1	10500	1050	5250	10000	7500	34300	52120
N_2P_2	10500	1050	5250	10000	7500	34300	52920
N_2P_3	10500	1050	5250	10000	7500	34300	52720
N_3P_0	10500	1050	5250	10000	7500	34300	52880
N_3P_1	10500	1050	5250	10000	7500	34300	52900

N_3P_2	10500	1050	5250	10000	7500	34300	53220
N_3P_3	10500	1050	5250	10000	7500	34300	58220

Labour cost @ Tk. 70/day.

Appendix IV. Contd.

(C) Overhead costand total cost of production (Tk.)

Treatment combination	Cost of lease of land	Miscellaneous cost (5% of input cost)	Interest on running capital for 6 months (10% of the total input cost	Total	Total cost of production (input cost+ overhead cost, Tk/ha)
N_0P_0	16000	2493	2493	20989	72856
N_0P_1	16000	2586	2586	21172	72892
N_0P_2	16000	2626	2626	21252	73772

$N_0 P_3$	16000	2560	2560	21120	72440
N_1P_0	16000	2606	2606	21212	73332
N_1P_1	16000	2646	2646	21292	74212
N_1P_2	16000	2581	2581	21162	72882
N_1P_3	16000	2626	2626	21252	73772
N_2P_0	16000	2666	2666	213432	74652
N_2P_1	16000	2606	2606	21212	73332
N_2P_2	16000	2646	2646	21292	74212
N_2P_3	16000	2636	2636	21272	73992
N_3P_0	16000	2635	2635	21291	74112
N_3P_1	16000	2720	2720	21391	74221
N_3P_2	16000	2732	2732	21391	74232
N_3P_3	16000	2762	2762	22112	74331

CONCLUSION

An experiment was conducted at the horticulture farm of Sher-e-Bangladesh Agriculture University, Dhaka. to evaluate the effects of nitrogen and phosphorus on the growth and yield of gimakalmi during the period of August to October 2006. The experiment consisted of four levels of nitrogen viz. control (No.), 50 kgN/ha (N_1), 75 kg N/ha (N_2) and 100 kg N/ha (N_3) and four levels of P_2O_5 viz. control (P_0), 65 kg P_2O_5 /ha (P_1), 75 kg P_2O_5 /ha (P_2) and 85 kg P_2O_5 /ha (P_3).

The two factorial experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. There were all together 16 treatment combinations in this experiment. Each unit plot size was 1.5 m x 1.2 m where 1.0 m and 0.5 m gap between blocks and plots respectively were maintained. The experimental plots were fertilized according to the specific doses of fertilizers. Nitrogen fertilizer were impliedly split doses. First dose 15 days, second dose 30 days and third dose 45 days after sowing.

All the phosphorus fertilizer applied during land preparation. The seeds of gimakalmi were sown on 15th August 2006 and harvested 30 days and 60 days after sowing.

All the intercultural operations were done and needed data of growth and yield parameters were collect and analyzed statistically. The mean difference were adjusted by least significant different (LSD) test.

Different levels of nitrogen doses significantly influenced all the parameters. Application of the 100 kg/ha nitrogen gave maximum plant height 64.16 cm and the maximum number of leaves (56.41) per plant at 60 DAS during period of final harvesting. At the final harvest (60 DAS) the maximum fresh weight. of leaves per plant (20.oo g), number of branches

(7.16) highest yield/plot (1291.66g), and dry weight of plants (8.27 g) were recorded from N_3 treatment which was significantly superior to all other nitrogen treatments.

However, the minimum plant height (37.08cm) number of leaves per plant (51.50) number of branches (5.25), fresh weight of leaves (18.66 g), yield per hectare (52.41 t), yield per plot (1000.00 g), dry weight of plant (7.00g) were recorded from control treatment (N_o). Phosphorus treatments also showed a significant difference on plant height ,number of leaves ,number of branches, fresh wt of leaves ,dry wt of plants ,yield per ha. ,yield per plot at final harvest. All these parameters showed to its maximum values in plants grown over P_3 treatment and the minimum values was in the control (P_0) treatment. The maximum values were in plant height (62.50cm), number of leaves (57.25), number of branches (7.08) fresh weight of leaves (19.25g), yield per ha (58.41t), yield per plot (1190.33g), dry weight of plant (8.77g) were recorded from p_3 treatments at final harvest. On the other hand the minimum plant height (52.66 cm), number of leaves (52.33), number of branches (6), fresh weight of leaves (17.00g), yield per ha. (52.41t), yield per plot (1091.66g), dry weight of plant (7.00) were recorded from control treatment (P_o).

Different levels of nitrogen as well as phosphorus had also significant combined effects on different parameters studied. The maximum plant height (68.83cm) number of leaves (61.66), number of branches (8.00), fresh weight of leaves (22.02g), yield per ha (62.66 t), yield per plot (1350.23g), dry weight of plant (9.20g) at final harvest (at 60 DAS),were observed in the treatment combination of N_3P_3 . However, minimum plant height (32.33cm) , number of leave (41.66), number of branches (4.14) ,fresh weight of leaves (15.33g), yield per ha.(55.00t), yield per plot (916.66g), dry weight of plant (6.36g) were recorded from control treatment (N_0P_0). The highest BCR (3.00) was obtained from N_3P_3 treatment combination,

while the lowest BCR (2.13) was recorded from control treatment (N_0P_0). The best performance was obtained from N_3P_3 treatment combination of fertilizer management for maximizing yield of gimakalmi.

In order to confirm the result of this study, further experiment is suggested since this experiment was conducted in one year and in a certain place only.

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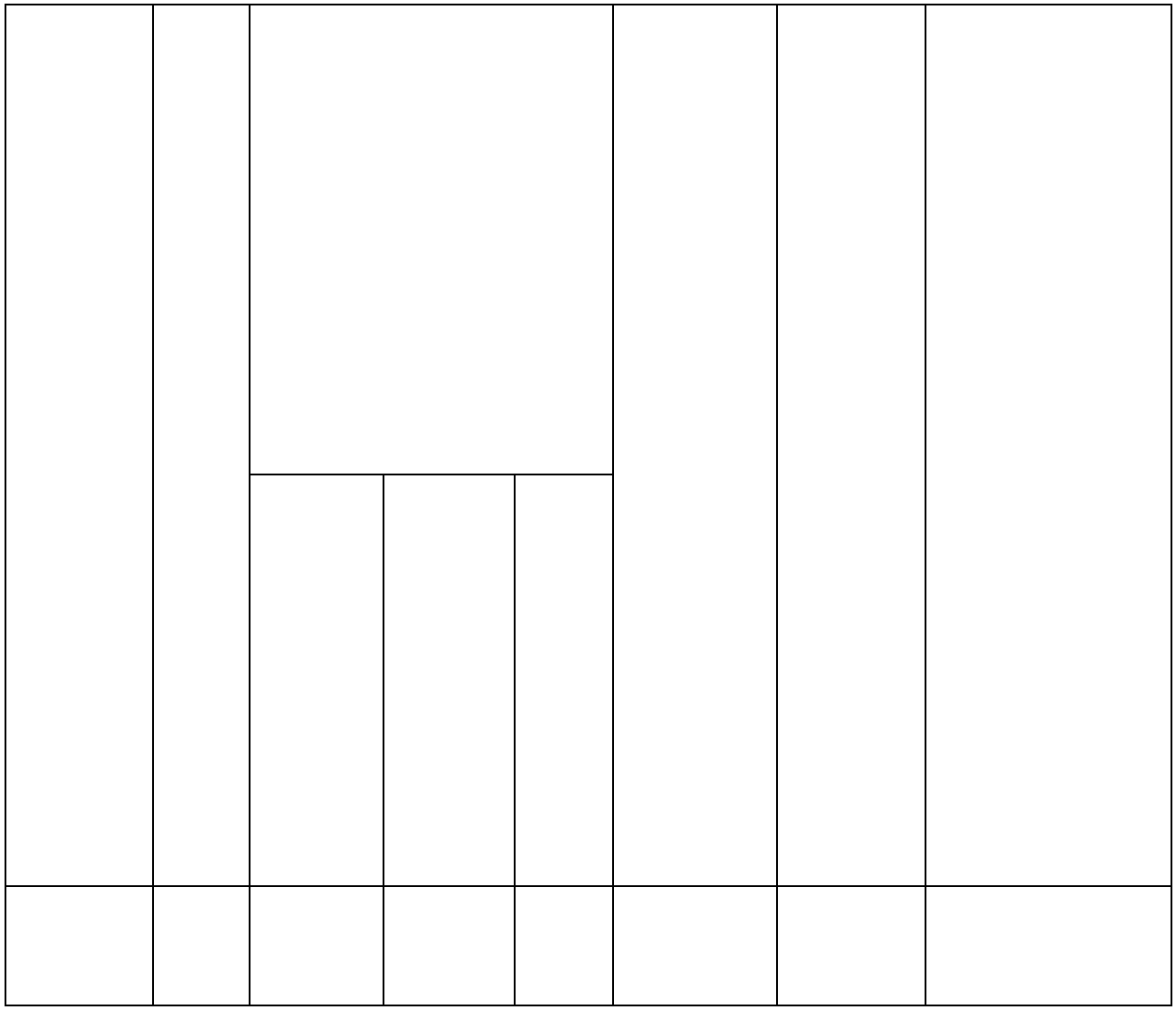
APPENDICES

Appendix I. Monthly record of year atmospheric temperature, relative humidity, rainfall and Sunshine hour of the experimental site during the period from Aug-October' 2006.



* Monthly average

** Monthly total

Source: Bangladesh Meteorological Department (Climate division) Agargoan, Dhaka-1212

Appendix II: Characteristics of Horticultural Farms soil is analyzed by soil Resources Development Institute (SRDI), Khamar Bari, Farmgate, Dhaka.

A.Morphological characteristics of experimental field.

Morphological features	Characteristics
Location	Horticulture Garden, SAU, Dhaka
AEZ	Madhupur Tract (28)
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained
Cropping pattern	Fellow-Gimakalmi

B.Physical and chemical properties of the initial soil.

Characteristics	Value
Partical size analysis	
% Sand	29
% Silt	41
%Clay	30
Textural class	silty-clay
P^H	5.60
Organic carbon (%)	0.45
Organic matters (%)	0.78
Total N (%)	0.03
Available P (ppm)	20.00
Exchangeable K (me/100g soil)	0.10
Available S (ppm)	45

Source: SRDI

Appendix : III Analysis of variance of different characters of Gima kalmi

Source of variation	d.f	Mean Square					
		Plant height(cm)					
		10 days after sowing	20 days after sowing	30 days after sowing	40 days after sowing	50 days after sowing	60 days after sowing
Factor A (Nitrogen)	3	.081**	3.019**	7.639*	55.021*	41.41**	3643.132**
Factor B (Phosphorus)	3	.692	1.672*	10.361**	.076**	30.132**	662.076**
Interaction (AB)	9	1.229*	.547	12.509**	11.87**	9.021**	345.873**
Error	30	.890	1.798	4.339	4.172	3.304	78.094

** =Significance at 1% level,
* =Significance at 5% level

Appendix : III Analysis of variance of different characters of Gima kalmi

Source of variation	d.f.	Mean Square					
		Number of leaves					
		10 days after sowing	20 days after sowing	30 days after sowing	40 days after sowing	50 days after sowing	60 days after sowing
Factor A (Nitrogen)	3	.521**	9.366**	15.632	132.076*	379.465*	9.722
Factor B (Phosphorus)	3	.743**	.436*	22.688	12.632**	16.465**	43.056
Interaction (AB)	9	.706**	.621	24.465**	29.354*	8.706	105.566*
Error	30	.310	2.220	7.106	7.933	11.876	50.035

** =Significance at 1% level,
* = Significance at 5% level

Appendix : III Analysis of variance of different characters of Gima kalmi

Source of variation	d.f	Mean Square					
		Number of branches					
		10 days after sowing	20 days after sowing	30 days after sowing	40 days after sowing	50 days after sowing	60 days after sowing
Factor A (Nitrogen)	3	0	1.879**	.847*	3.611*	9.576*	.410
Factor B (Phosphorus)	3	0	1.312**	.319	2.333*	2.576*	.299
Interaction (AB)	9	0	1.449**	.917**	2.093*	1.410*	.743
Error	30	0	.164	.296	.311	0.393	.550

** = Significance at 1% level,
* = Significance at 5% level

Appendix : III Analysis of variance of different characters of Gima kalmi

Source of variation	d.f	Mean Square	
		Fresh weight of leaf per plant	
		30 days after sowing	60 days after sowing
Factor A (Nitrogen)	3	8.056**	10.472
Factor B (Phosphorus)	3	4.556*	2.750
Interaction (AB)	9	12.944**	10.472*
Error	30	1.518	3.474

** = Significance at 1% level,
* =Significance at 5% level

Appendix : III Analysis of variance of different characters of Gima kalmi

Source of variation	d.f	Mean Square	
		Dry weight per plant(g)	
		30 days after sowing	60 days after sowing
Factor A (Nitrogen)	3	1.262	.935
Factor B (Phosphorus)	3	3.312	4.769**
Interaction (AB)	9	1.033	2.147
Error	30	0.609	.920

** = Significance at 1% level,
* =Significance at 5% level

Appendix : III Analysis of variance of different characters of Gima kalmi

Source of variation	d.f.	Mean Square	
		Yield /ha(t)	
		30 DAS	60 DAS
Factor A (Nitrogen)	3	17.36**	48.24**
Factor B (Phosphorus)	3	10.19 **	10.57**
Interaction (AB)	9	5.97*	4.96*
Error	30	5.46	6.52

** = Significance at 1% level,
* = Significance at 5% level

Appendix : III Analysis of variance of different characters of Gima kalmi

Source of variation	d.f.	Mean Square	
		Yield /plot(g)	
		30 DAS	60 DAS
Factor A (Nitrogen)	3	21674.30**	69496.52**
Factor B (Phosphorus)	3	9040.97**	43107.63*
Interaction (AB)	9	8787.71**	34126.15**
Error	30	15022.91	23402.77

** = Significance at 1% level,
* = Significance at 5% level

Appendix IV. Production cost of GimaKalmi per hectare

(A) Material cost (Tk.)

Treatment combinations	Seed (Kg/ha)	Fertilizer and manure				Irrigation	Sub total 1(A)
		Cowdung	Urea	TSP	Mp		
N_0P_0	8000	6000	-	-	1120	1500	16620
N_0P_1	8000	6000	-	400	1120	1500	17020
N_0P_2	8000	6000	-	800	1120	1500	17420
$N_0\ P_3$	8000	6000	-	1600	1120	1500	18220
N_1P_0	8000	6000	400	-	1120	1500	17020
N_1P_1	8000	6000	400	400	1120	1500	17420
N_1P_2	8000	6000	400	800	1120	1500	18220
N_1P_3	8000	6000	400	1600	1120	1500	18110
N_2P_0	8000	6000	800	-	1120	1500	17880
N_2P_1	8000	6000	800	400	1120	1500	17820
N_2P_2	8000	6000	800	800	1120	1500	18420
N_2P_3	8000	6000	800	1600	1120	1500	18620
N_3P_0	8000	6000	1200	-	1120	1500	18810
N_3P_1	8000	6000	1200	400	1120	1500	18990
N_3P_2	8000	6000	1200	800	1120	1500	19100
N_3P_3	8000	6000	1200	1600	1120	1500	19420

Seed @ Tk. 8000 /Kg

Cowdung @ Tk. 600/ ton.

Urea @ Tk. 8 /kg.

TSP @ Tk. 16/kg

Appendix IV. Contd.

(B) Non-material cost (Tk./ha)

Treatment combination	Land Preparation	Fertilizer and manure application	Seed sowing and bed preparation	Intercultural operation	Harvesting	Sub total	Total input cost 1(A) + 1(B)
N_0P_0	10500	1050	5250	10000	7500	33250	49870
N_0P_1	10500	1050	5250	10000	7500	34300	51720
N_0P_2	10500	1050	5250	10000	7500	34300	52520
$N_0\ P_3$	10500	1050	5250	10000	7500	34300	51320
N_1P_0	10500	1050	5250	10000	7500	34300	52120
N_1P_1	10500	1050	5250	10000	7500	34300	52920
N_1P_2	10500	1050	5250	10000	7500	34300	51720
N_1P_3	10500	1050	5250	10000	7500	34300	52520
N_2P_0	10500	1050	5250	10000	7500	34300	53320
N_2P_1	10500	1050	5250	10000	7500	34300	52120
N_2P_2	10500	1050	5250	10000	7500	34300	52920
N_2P_3	10500	1050	5250	10000	7500	34300	52720
N_3P_0	10500	1050	5250	10000	7500	34300	52880
N_3P_1	10500	1050	5250	10000	7500	34300	52900
N_3P_2	10500	1050	5250	10000	7500	34300	53220
N_3P_3	10500	1050	5250	10000	7500	34300	58220

Labour cost @ Tk. 80/day.

Appendix IV. Contd.

(C) Overhead cost and total cost of production (Tk.)

Treatment combination	Cost of lease of land	Miscellaneous cost (5% of input cost)	Interest on running capital for 6 months (10% of the total input cost)	Total	Total cost of production (input cost+ overhead cost, Tk/ha)
N_0P_0	16000	2493	2493	20989	72856
N_0P_1	16000	2586	2586	21172	72892
N_0P_2	16000	2626	2626	21252	73772
$N_0\ P_3$	16000	2560	2560	21120	72440
N_1P_0	16000	2606	2606	21212	73332
N_1P_1	16000	2646	2646	21292	74212
N_1P_2	16000	2581	2581	21162	72882
N_1P_3	16000	2626	2626	21252	73772
N_2P_0	16000	2666	2666	213432	74652
N_2P_1	16000	2606	2606	21212	73332
N_2P_2	16000	2646	2646	21292	74212
N_2P_3	16000	2636	2636	21272	73992
N_3P_0	16000	2635	2635	21291	74112
N_3P_1	16000	2720	2720	21391	74221
N_3P_2	16000	2732	2732	21391	74232
N_3P_3	16000	2762	2762	22112	74331