

## Effects of sowing date, cropping pattern and nitrogen on CGR, yield and yield component summer sowing buckwheat (*Fagopyrum esculentum* Moench)

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### ABSTRACT

In order to investigate the effects of sowing date, cropping pattern and nitrogen on buckwheat seed yield, The experimental design of the experiment was randomized complete blocks with split plot factorial arrangement with three replications in Arak Agricultural Research Center in 2010. the main plot is considered to be the treatment of the pattern of planting which is studied in two levels, in the first on the mound is 50 cm wide with 2 rows of planting with a 20 cm distance in between ( $P_1$ ) in the second one the mound is 60 cm wide with 3 rows of planting with a 15 cm distance in between ( $P_2$ ). Sowing date and nitrogen are considered as Sub plots. The sowing dates are studied on June 20th ( $D_1$ ), July 5th ( $D_2$ ), July 20th ( $D_3$ ) and August 5th ( $D_4$ ). The effect of nitrogen is studied in 4 levels in clouding  $N_1$  (0 kg),  $N_2$  (50 kg),  $N_3$  (100 kg) and  $N_4$  (150 kg).

The results show that the pattern of planting influenced the number of bunch in the plant the number of seed in each bunch. the sowing date in flounced seed yield the CGR, the weight of thousand seeds in each bunch and the harvest index the amount of nitrogen in flounced the CGR, weight of thousand seeds the number of bunch in the plant and the number of seeds in each concerning the dual mutual effect, the pattern of planting and nitrogen affected seed yield, the CGR. The number of the seeds in each bunch and the harvest index. The sowing date and nitrogen affected seed yield, CGR and number of bunch in the plant. These three factors sowing date  $\times$  nitrogen  $\times$  pattern of planting in flounced the seed yield, the CGR, the number of bunch in the plant, the whole number of seeds in each bunch and the harvest index. Consequently, the most seed yield was 2980 kg/ha-1, the weight of thousand seeds was 29.93 gr the whole number of the seeds in the plant were 468.5 and harvest index was 74.56 percent. These were resulted  $P_2D_3N_3$  second pattern of planting, third sowing date, and the use of 100 Kg nitrogen  $P_2D_2N_4$  treatment had the fastest CGR 16.72 gr the most number of bunch in the plant was gained by  $P_2D_2N_3$  treatment, that was 51.5.

**Key words:** Buckwheat, cropping pattern, sowing date, nitrogen, summer sowing.

### INTRODUCTION

Buckwheat with scientific name of *Fagopyrum esculentum* is an annual wide leaf from polygonaceae family which is well known as fake cereals. Its seeds are used as a nutritional and pharmacological product that this characteristic refers to its rutin content. The flour made by seeds of this plant have a healing effect on control and improvement of diabetes and also cause the cure of hardening of brain arteries tissues, diseases related to heart arteries and high pressure diseases (5, 38).

Nutritional value of the seeds of this plant are more than seeds of real cereals and is considered as an excellent source of high quality protein and a rich source of required Amino Acid lysine, the amount of which is very low in cereals (19). Moreover, having a high percent of starch, minerals, and vitamins, it is used for making cake flour, grouts, soap and so on (36). This plant is not sowed in Iran as a major crop. Considering the raise of world's population and living conditions of human society there is a need for more nutrients with a higher quality, on the other hand, with the ecological condition of the country and since the plant has low nutritional expectations and can raise relatively successful in poor and non fortik soils, developing it's planting with such desirable characteristics and nutritional pharmacological uses is a good choice for agriculture (4; 1, 21).

Speed of growth of the product has a direct relationship with the amount of day material produced and is a criterion for potential of performance, therefore the amount of production and condensation of dry material in the plant can be studied as an indicator of growth speed of the crop (33; 39; 6,41). Also the effect of mixed fertilizers N.P.K on weight increase of dry material of the plant is reports (16).

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Yield of plants is the result of inter and intra species competitions for achieving potential facilities of the environment and the maximum performance in surface unit can be gained when these competitions are minimum. One way to minimize these competitions is accurate distribution of plants in unit of surface, because the space between sowing rows and also the space between the space for each plant and therefore the extractable performance (27). In assessing plant density (125, 250, 375, 500) in unit of surface and the space between sowing rows (12, 24, 36, 48 cm) the best performance and performance components was found to be in 125 plant in 36 cm rows. It is found that sowing array in the from plays and effective role in the way light is distributed within the plant cover (22) in sowing date experiment (middle may) in 12.5 cm rows with 200 plant density per hectare showed the effect of environmental conditions on the seed filling periods, also reported the correlation between protein and starch stem diameter.

Therefore, uniform distribution of plants in closer sowing rows causes more effective use of sources and delay in the beginning of intra species competition which in turn leads to better light emissions in the system and will increase net light absorption such a uniform distribution in the unit of surface will be gained when the spaces between plants is equal from all directions that is square sowing pattern. In this sowing pattern besides minimizing the competition for absorbing light, the plant ghosting receives the light completely and so the plant output will increase (6). This increase may be resulted from the changes in allocation of photosynthetic material between growing and generative organs and because photosynthetic materials go to generative organs then components of performance will be effected (18, 20).

Different sowing dates used in different ecological conditions affect plant growth time period and plays a major part in yield (23).

The aim of determining sowing date is to find a good time for planting a type or a group of similar type of plant, so that the whole environmental factors in that time be suitable for germination, establishment and survival of the plant. Suitable sowing time is one of important and effective factors for having a satisfying agricultural output. (27) have reported late may sowing as the best sowing date among late April, early may late may early June, and late June as it gives 2059 kg out put in a hectare.

By choosing the best sowing time, different stages of plant growth come in accordance with preferred environmental conditions that lead to increase of photosynthesis output and there for a good photosynthetic material storage and increase of yield and its components will be resulted.

Bernat (2000) has reported middle may line as the sowing time in Europe. On the contrary, inappropriate sowing time cause poor environmental condition for sensitive stages in plant growth and leads to decrease of yield and its components.

Halbre & Lendent (2004) reported that sowing date affects the number of seeds in each plant. Plant need sufficient nutritional element for optimal growth. One of these highly needed elements is Nitrogen which is very important. Vinod Kumer Sharma (2005) in an experiment of sowing date June 20th June 25th and different Nitrogen levels (0.20-40-60) Kilograms per hectare reported that the most number of branches in a plant weight of thousand seeds and yield can be achieved in June 25th with 60 kg Nitrogen per hectare.

Nitrogen is the most important element in reforming the condition of nutrients of soil which in turn has the most effect on maximizing crops production (8, 47, 12). The effect of different Nitrogen levels on characteristics of buckwheat was reported (45).

## MATERIALS AND METHODS

This experiment was pre formed in 2010 in an Agricultural Research from in Markazi province, Iran, exactly located two Km North city of Arak 34, 5 Northern and 49, 42, from prime meridian and 1557 m Height from sea in a piece of land with loamy clay soil texture PH. 7.6 and electric conduction of saturated soil water mix 1.28 dsm/m<sup>-1</sup>. Rain fall during the time period of the experiment was 0 mm according to metrological reports, and the average annual temperature according to this station was 24.6 this experiment was performed as a split plot factorial plan in the form of randomized complete blocks in three replications, treatments included P (planting pattern) as the main factor in two levels, (P<sub>1</sub>) 50 cm mound width with two sowing rows in 20 cm intervals and (P<sub>2</sub>) 60 cm mound width with three sowing rows in 15 cm intervals and sowing date treatments (D) in 4 levels including D<sub>1</sub> June 20th, D<sub>2</sub> July 5th D<sub>3</sub> July 20th, and D<sub>4</sub> August 5th, and Nitrogen (N) in 4 levels including zero kg (N<sub>1</sub>), 50 kg (N<sub>2</sub>), 100 kg (N<sub>3</sub>), and 150 kg (N<sub>4</sub>) were subplots factors.

The space on sowing line was considered, regarding constant density (100 plants / m<sup>2</sup>) 4 cm for P<sub>1</sub> and 5 cm for P<sub>2</sub>.

Size of each test Plot in P<sub>1</sub> 1.6 × 2 m and 1.6 × 2.4, for P<sub>2</sub> had 4 sowing rows. The sowing operation was handed manually in June 20th July 5th, July 20th, and August 5th, Distribution Of nitrogen fertilizer was performed in to phases, first in 4 leaf plant second in 8 leaf plants in the farm.

Considering low Nitrogen absorption in buck wheat giving fertilizer in parts will be very useful (Zhu et al, 2002).

Since the temperature index has less seasonal fluctuation compared to time in this study growth day degree (GDD) was used instead of calculating growth speed index. Growth day degree was calculated considering weather statistics and plant biological zero in each sampling stage using the relation below:

$$GDD = \sum_{i=1}^n [(T_{\max} + T_{\min}) / 2] - T_b$$

Where GDD is growth day degree, n is number of days between sampling stages, T max maximum temperature in 24 hours, T min is minimum temperature is 24 h , and T b is basic temperature. Basic temperature for back wheat was set as 5oc. Temperatures higher than 30oc were considered 30oc In order to study plant growth speed trend in this test the below relation was used based on GDD:

$$CGR = \frac{\Delta W}{\Delta GDD}$$

Where  $\Delta w$  is the difference between dry bush total weight in the two sampling stages and  $\Delta GDD$  is the difference between cluster temperatures in time intervals between two sampling stages. Sampling was done in 5 stages, omitting two side lines. And half a meter from top and down every test plot, randomly selecting 5 plants, one every fortnight and then sample moved to laboratory put into oven and dried in 75 °C for 48 hours and finally weighed as the dry bush weight In order to calculate the final yield of seed, total seeds existing in square meter (based on 12% humidity) as the criterion for seed yield per hectare. In order to determine the number of clusters in whole plant and total number of seeds in the plant, 5 plants were randomly selected and the number of clusters and seed were counted and its mean were used.

For determining harvest index the below relation was used:

Harvest index= grain yield/biological yield  $\times$  100

And in order to determine the weight of thousand seeds, & one hundred samples, the seed related to each weighing treatment. And their average was multiplied in 10. All statistical calculations and analysis of Variance were performed using SAS software, Ms Excel was used for drawing curves and the means gained in the test were compared in 5% probability level using Duncan test.

## RESULTS AND DISCUSSION

### Crop Growth Rate (CGR):

Crop growth rate index shows the speed of plant dry material increase in unit of ground surface in unit of time the unit of which is gram per square meter in day or clustered temperature In early growth because there is no plant cover on the ground surface and missing a huge amount of sun light CGR is low but with increase of plant leaf surface the CGR also increases and usually reaches its maximum in flowering and fruit stages. Treadweel et al 2008 reported in a research that in case there is no heat plating in 15 to 20 cm rows will produce maximum dry material in 6 weeks after planting.

After this stage as the material production decreases in the plants the CGR is fixed and gradually takes a decreasing trend. This decrease happens while the plant, instead of producing new material is rather moving photosynthetic material from various organs to the seed, then fore total weight of the bush remains approximately constant.

Near the ripening stage, leaves start falling and the surface of photosynthesis decreases. Hence, CGR reaches negative values. Karimi & Sidik (1991) has reported the effect of temperature and day length in faster growing development of back wheat (39).

Table 1 shows the results of plant growth rate in various stages of this experiment. As indicated in the table, there is significant and the plant growth rate in 15,30, 45, and 60 days after sowing expect for plain effect of planting pattern in 45 and 60 days after sowing. In this test the maximum observed GDD was 800-900 and then reached an approximately fixed value and at last took a decreasing trend even showing negative values the negative plant growth rate in late growth season is also because of leaves fall.

Diagram 1 shows the trend of CGR changes in planting pattern. The higher CGR in planting pattern of 50 cm mound width with two sowing rows in 20 cm space is related to plant's having sufficient space for getting more light and higher growth rate. Cawoy et al (2008) reported 900 – 1100 °C needed from flowing to browning of the seed that a temperature between 500oc is reasonable for maximum growth in this experiment considering the shorter growth period and high temperature is summer.

Brunori et al (2005) in Italy tested 5 types of buck wheat with density of 300 bushes in a square with planting pattern of 25 cm rows and 15 kg nitrogen and reported that there is a positive correlation between wet and dry weight and seed yield and a negative correlation between yield and harvest index.

Diagram 2 shows the trend of CGR changes in 4 planting dates. And the Higher CGR in the third planting date is because of appropriate temperature during growth development that besides increasing CGR is a major cause for increasing yield.

Table1: Variance analysis of characters Ms

Source of variation	Degree of freedom	Mean squares			
		15 day after planting gr.m <sup>2</sup> /GDD	30 day after planting gr.m <sup>2</sup> /GDD	45 day after planting gr.m <sup>2</sup> /GDD	60 day after planting gr.m <sup>2</sup> /GDD
R	2	0.015	1.82	0.11	0.102
P	2	218.07*	26.04*	16.62n.s	4.88
E	2	0.048	0.74	2.4	0.09
D	3	2.13**	335.32**	272.3**	59.14
P×D	3	0.94**	5.47*	232.38**	82.11**
N	3	0.46**	16.75**	52.43**	139.92**
P×N	3	0.78**	10.64**	26.41**	68.19**
d×N	9	0.84**	16.97**	43.42**	65.77**
P×D×N	9	0.85**	5.69	48.43**	288.92**
E	60	0.46	1.56	1.63	0.13
C.V%		13.13	17.65	18.33	22.98

n.s\*, \*\*. Non significant, significant at the 5%, 1% level of probability

#### Seed Yield:

The most important characteristic examined in every test to which almost all conclusions will be dedicated is seed yield per hectare because components of yield will lead to this factor.

Final yield of buck wheat depends on several environmental and internal factors. Having various treatments in this experiment could again influence the yield. As indicated in table one yield influenced by date of planting, pattern of planting and nitrogen that in these simple effect treatments date of planting and nitrogen show a significant difference in 1% level, and in mutual effect treatments planting pattern in date of planting in 1% level and planting pattern in nitrogen were significant in 5% level.

The third planting date with the mean yield of 2442.1 kg in hectare had the most yield and the most yield in treatments of planting pattern in planting date was P<sub>2</sub>P<sub>3</sub> treatment with 2710.8 kg, in nitrogen fertilizer treatment was N<sub>3</sub> with 2300.20 kg per hectare in planting pattern in Nitrogen with 2420.8 kg in hectare in planting date nitrogen fertilizer treatment it was D<sub>3</sub>N<sub>3</sub> with 2761.7 kg triple effect of treatments also had a difference in 5% level, so that the more seed yield with 2980 kg was D<sub>2</sub>P<sub>3</sub>N<sub>3</sub> treatment Hore & Rati (2002) reported the most planting date in August in India. They reported the most protein percent in buck wheat as 11.7 %.

Hore & Rati (2002) found the most seed yield as 2699 kg for VL07 type Chang et al (2003) said in a report that the least yield was 821 kg and the most yields was 1890 kg. Moat et al (2003) reported the most buck wheat yield as 2000 kg.

The results show that the third planting date among all, besides making appropriate conditions could increase the yield through temperature in early growth, flowering date causes yield decrease and managing late planting times is more difficult than early planting dates (41). The best summer planting date is reported to be July and August (42).

In planting pattern, regarding fixed density bush distribution in 60 cm wide mounds and 3 sowing rows compared to 50 cm wide mounds with 2 rows decreased intra species competition and increased the share of each plant in light, water and nutrients absorption from roots more effectively. Nitrogen fertilizer is more luxurious and less effective for yield. Increase of nitrogen as it provokes growing development and decreases generative period and since in summer sowing the temperature is a reactor factor making the plant grow faster using 150 kg nitrogen causes less photo synthetic material allocating to seeds.

Growth and production of seed in plants depends on 3 carbon sources, including current assimilation transporting stored assimilates before flowering and transporting stored assimilates after flowing and it is proved that light temperature water and size and combination of seed are effective yield of plants in high temperature (summer) depends on all factors of especially determining suitable planting time in order to determine source of carbon and decrease seed filling period not the rate of filling are highly important (37) In a test treating density (row spaces 30, 40, and 50 cm) and seed yield was 3.21, 2.85 and 2.48 kg in hectare (15) Phogat & Sharma (2002) reported from India that adding 50 kg Nitrogen 20 kg phosphor and 40 kg Potassium make a raise in buck wheat yield.

An experiment in various densities of planting and Nitrogen it was found that having 33.3 bughes in a square with 100 kg nitrogen leads to highest yield(34) More over it seems that colder micro condition within canopy in P<sub>1</sub> causes keeping more soil moist and effects yield (10).

Chinese researchers (26, 31) reported buck wheat yield 2500 kg in hectare, Brur Nori et al (2005) in examining 5 types in Italy reported the highest yield in type La Harpe that equals 2379 kg.

Components of yield:

### 1000-grain weight:

1000 grain weight was examined under the effect of all test treatments that the results of analysis of variance shows that table 1 among simple effects treatments, planting date and nitrogen treatments of double and triple effects were not significant the highest weight of 1000 seeds was in D<sub>3</sub> July 20th as 29.25 grams and the top weight in fertilizer treatments was 100 kg nitrogen (N<sub>4</sub>) as 28.37 g. Despite insignificance of other treatments considering the table 2 of mean comparison for double effect of planting date and nitrogen fertilizer highest seed weight was in D<sub>3</sub>N<sub>3</sub> treatment and among triple effects treatment of planting date and planting pattern and Nitrogen it was D<sub>3</sub>N<sub>3</sub>P<sub>2</sub>. Zhong & Yaa (1998) have reported the effect of nitrogen Fertilizer on increase of seed weight.

It can be said that in this planting date because of better growing conditions due to temperature and coincidence of flowering and insemination flowers with more activity of insects and appropriate weather, more nutrients and photosynthetic materials are transmitted to the plant. Weight of 1000 seeds is one of the most important factors deter mining yield. Having well filled large seeds will also increase the yield. Final seed size is largely variable between genotypes and various environmental conditions. Tuo (2002) Zhong (1998) & Kalinoua (2006) reported increase of 1000 seeds weight with increase of temperature and use of Nitrogen fertilizer. The effect of temperature (summer sowing) on number of seed lings was reported by Feng (2001).

Moreover, Heikkinc (1991) considers seed weight as the most constant component of yield in different condensations Kalinove et al (2005) reported a relationship between number of seeds and weight of 1000 seeds.

Table 2: Variance analysis of characters MS

Mean squars						
Source of variation	Degree of freedom	Grin Yield	1000 seed weight	Number in head plant	Number in total seed plant	HI
R	2	19239.64	0.42	0.77	541.3	45.74
P	2	96241.35n.s	2.01**	187.88*	22059.9**	184.26n.s
E	2	65111.71	0.83	7.21	781.61	57.89
D	3	2484113.8**	28.52**	956.85**	168996.1**	3821.35**
P×D	3	738200.8**	3.4n.d	259.52**	883.7n.s	70.96n.s
N	3	155002.5n.s	5.12*	70.84**	2883.2**	40.61n.s
P×N	3	756578.3*	1.36n.s	266.992**	3907.94**	445.11**
d×N	9	518076.7*	1.48n.s	132.67**	14591.76**	31.66n.s
P×D×N	9	553755.8*	0.55n.s	126.67**	6668.45**	76.29**
E	60	183728.35	1.63	7.3	339.17	32.42
C.V%		19.26	4.45	22.41	13.39	10.39

n.s\*, \*\*. Non significant, significant at the 5%, 1% level of probability

### Number of cluster in plant:

Number of clusters in the plant in one of components of yield that was put under effect of planting date, planting pattern and nitrogen in this experiment and the results are shown in table 1 ANOVA where a significant difference in 1% level is indicated for simple effect and double and triple effects As indicated in table 2 (comparison of means) second planting date D<sub>2</sub> with 28.62 cluster per plants and planting pattern P<sub>2</sub> with 23.56 and Nitrogen treatment N<sub>4</sub> with 24.54 showed most cluster per plants.

In double effect treatments, planting pattern in planting date D<sub>2</sub>P<sub>2</sub> with 34.87 clusters per plant and in planting pattern and Nitrogen D<sub>2</sub>N<sub>4</sub> with 38.33 cluster per plant were at the top of list.

In triple effect treatments D<sub>2</sub>N<sub>4</sub>P<sub>2</sub> with 51.5 showed the highest number of cluster per plant. It can be concluded from the results that p<sub>2</sub> gives sufficient space for making more cluster and D<sub>2</sub> is the time when higher temperature gives way to faster growth followed by more nitrogen fertilizer use that sets good conditions for lateral buds on the stalk. Liuj, (2002) and Klu (2003) found that 1.05 million bushes in a hectare is the best density and reported a positive correlation between density and number of flowers and buds. Moreover, Cawoy (2007) said in a report that number of clusters on the main stem is 6.

Table 3: Mean comparison of main effects

treatment	Fat percentage	Protein percentage	Carbohydrate percentage	Grin yield	Number of leaves
<b>P</b>					
P1	2252.7a	27.83a	20.76	122.34b	50.96a
P2	2189.3a	28.2a	23.56a	152.66a	53.46a
<b>D</b>					
D1	2266.2a	27.01c	19.81c	102.30c	41.56c
D2	24.22.7a	28.5b	28.62a	129.44b	41.96c
D3	2442.1a	29.25a	25.77b	256.2a	57.32b
D4	1753.1b	27.13c	14.43d	61.58d	67.46a
<b>N</b>					
N1	2189.6a	27.74b	21.68b	127.7b	41.56c
N2	2320.8a	28a	20.45b	152.93a	53.28a
N3	2320.8a	28.37a	21.95b	135.7b	51.06a
N4	2242.1a	28.06a	24.54a	134.3b	53.12a
<b>(P×D)</b>					
P1D1	1716.7d	26.9b	19.21b	243.78b	41.35de
P1D2	2158.3b	27.7b	22.37de	87.06ef	39.35e
P1D3	2456.9ab	29.37a	26.58b	106.01de	54.23c
P1D4	2425ab	27.35b	14.87e	52.35g	67.85a
P2D1	1789dc	27.11b	20.40d	152.76c	41.77de
P2D2	2274ab	29.31a	34.87a	118.52d	44.56d
P2D3	2710.8a	29.14a	24.95bc	268.54a	60.42b
P2D4	2134.6bc	26.9b	14e	75.81fg	67.1a
<b>(P×N)</b>					
P1N1	1961.7b	27.61a	22.04b	115.16d	44.59d
P1N2	2155.8ab	27.74a	19.95bc	118.93cd	54.5ab
P1N3	2402.5a	27.64a	22.83b	127.5b-d	47.46cd
P1N4	2301.7ab	28.33a	18.27c	127.79b-d	56.23a
P2N1	1993.3b	27.32a	21.32bc	138.9bc	57.12a
P2N2	2239.2ab	28.35a	20.95bc	186-9a	52.06bc
P2N3	2490.8a	28.38a	21.08bc	143.9b	54.65ab
P2N4	2223.3 ab	28.42a	30.887a	140.83bc	50.02bc
<b>(D×N)</b>					
D1N1	2277.5a-e	26.16g	18.65e-g	180.75c	41.81f
D1N2	2215a-c	26.68e-g	23.66c-e	180.5d-f	40.58f
D1N3	1726.7cd	27.95b-f	16.33f-h	222.25b	42.88f
D1N4	2436.7a-c	27.25d-g	20.6d-f	246.08b	40.96f
D2N1	2198.3a-c	28.23a-e	28.53bc	114.79de	40.06f
D2N2	2516.6ab	28.3a-e	23.25c-e	76e-g	43.58f
D2N3	2503.3ab	28.48a-d	24.33dc	119.63de	41.53f
D2N4	2550ab	29.01ac	38.33a	100.75e-g	42.66f
D3N1	1726.7 c-d	28.8a-d	23.58c-e	144.5cd	56.13de
D3N2	2545ab	29.4ab	22.41de	375.75a	61.4b-d
D3N3	2263.3a	29.76a	32.16b	130.63de	52.13e
D3N4	2530.ab	27.89b-f	24.91cd	134.17de	59.65cd
D4N1	1787.5cd	26.68e-g	15.97f-h	68.25gh	65.41a-c
D4N2	2006.7bc	27.86b-e	12.5h	51.5gh	67.56ab
D4N3	1766.7cd	26.5fg	15f-h	70.33h	67.7ab
D4N4	1451.7d	27.48c-g	14.33gh	56.25h	69.23a

### Number of seeds in the plant:

Simple, double and triple effect of different levels of planting pattern planting date nitrogen fertilizer on number of seeds phenotype in the plant was significant in 1% level. As the comparison of means (table 2) showed the highest number of seeds per plant for planting pattern treatment was P<sub>2</sub> with 152.66 for planting date it was D<sub>3</sub> with 256.2 and for Nitrogen fertilizer it was using 50 kg with 152.9. Highest number of seeds per plant in double effect treatments for planting pattern and date was P<sub>2</sub>D<sub>3</sub> with 268.54 for planting pattern and nitrogen it was P<sub>2</sub>N<sub>2</sub> with 186.9 and for planting date and nitrogen it was P<sub>2</sub>D<sub>3</sub> N<sub>2</sub> with 468.5.

Obviously increased number make the conditions to provoke flowering there for increased number of seeds before pollination Ota et al (1999). And Inoue et al (2004) reported undesirable environmental conditions in time of pollination as one of the most important factors in perfect fertilization.

And the pattern of 60 cm wide mound with three sowing rows with preparing, more flowers in the main to sub-stem and sub-stem to sub-stem made the most seeds and in this conditions 50 kg nitrogen considering environmental conditions (high temperature) in D<sub>3</sub> and unlimited growth of plant could increase number of



seeds more than other nitrogen levels. Correlation between number of seeds and seed yield is reported by researchers (28, 24, 13).

It seems that negative correlation between number of seeds, seed yield and weight of 1000 seeds in this experiment is due to summer sowing Cawoy et al (2008) reported the effect of planting date on overage number of green and ripe seeds Holberg & Lendent (2004) said in a report that planting date affects seed number Harvest Index (HI).

In examining this phenotype with rest treatments (table 2) among simple treatments only planting date was significant in 1% level of probability and in double effect planting pattern and nitrogen fertilizer was also significant in 1% level and triple effect was only significant in 5% level of probability Then means can be seen in table 2.

The highest HI for planting date was in D<sub>4</sub> with 67.46% and for planting pattern and nitrogen fertilizer it was P<sub>2</sub>N<sub>4</sub> with 57.12% and for triple effects it was P<sub>2</sub>D<sub>4</sub>N<sub>4</sub> with 74.56%.

These results indicate that with a delay in planting the time period of plant growth gets shorter so there is not enough time for development of growing organs and the plant enters generative stage immaturely.

There for, it seems that by shortening growth and development of growing organs the growing part of the plant gets less share of biological output and the HI is increased as a result Brunori et al 2005 tested 5 types of buck wheat with 300 bushes in square meter in 25 cm rows and 15 kg nitrogen in Italy and yield and reported a negative correlation between yield and HI.

In D<sub>4</sub> environmental; condition including temperature is in the best condition for moving photosynthetic materials from point of origin to the destination.

In planting pattern of 60 cm wide mounds with 3 sowing rows more flowers are produced in plants because plants are distributed optimally and 150 kg nitrogen fertilizer is used that leads to more seeds and higher transmission of photosynthetic materials to seeds .

Inoue et al (2000) tested 50 cm rows with 40 bushes per m<sup>2</sup> and found it necessary to study HI and components of yield with duration of environmental conditions.

These results are in accordance with Thakuvia (2000) and Zakara(1997) who reported that using N-P-K mixed fertilizer and more nitrogen increases HI. Brunori et al (2005) in Italy examined 5 types of buck wheat and reported the highest HI in La-Harpe type (56%).

Table 4. Mean comparison of main effects

treatment	Grin yield (kg ha <sup>-1</sup> )	100 seed weight (gr)	Number in head plant	Number intotal plant	HI %
P1D1N1	2320bh	24.4gh	22ci	200cd	32.46k
P1D1N2	2273bi	26.5gh	23.16ch	283b	42.46h-k
P1D1N3	2283.3bh	27.4ah	17.5hi	241cd	42.23h-k
P1D1N4	2916.7ad	27.33ah	14.2i-l	278.5b	46.93g-i
P1D2N1	1780ej	27.63ah	25 bf	85.33i-l	35.93i-k
P1D2N2	2936.6ac	27.5ah	23.33ch	70.50l-m	43.3h-j
P1D2N3	2396.7bg	27.46a-h	16gl	98.75j-l	37.6 j-k
P1D2N4	2586.7af	28.2a-h	25.16bf	93.67j-l	40.56h-k
P1D3N1	1916.7ej	29.46ad	22ci	105.17j-l	51.5e-h
P1D3N2	2566.6ag	28.86af	19.33d-l	92j-l	61.5c-e
P1D3N3	1170j	29.4ae	43.66a	138.75fj	41.06 hk
P1D3N4	2980ab	29.76ab	21.33c-i	88.5j-i	62.68b-d
P1D4N1	1830ej	26.96ch	19.16f-l	70.1 km	57.43 df
P1D4N2	1833.3ej	28.1ah	14j-l	30.25m	70.73ac
P1D4N3	1723.3gi	26.3gh	14.16jl	58.5lm	68.66 a-c
P1D4N4	1480hj	28.3ah	12.16kl	50.5lm	70.73a-c
P2D1N1	2235bi	25.93h	15.3hl	161.5dh	50.6fh
P2D1N2	21.56.7bi	26.86fh	24.16bg	122.5g-k	38.7ik
P2D1N3	2190bi	28.5ag	15.16il	230.5bc	43.23h-k
P2D1N4	1956.7ej	27.16ch	25.16bf	213.67ed	35jk
P2D2N1	2616.7ac	28.83af	32.16b	144.25e-j	44.16hk
P2D2N2	2096.7ac	29.5ac	32.66b	81.5j-m	43.89hk
P2D2N3	2610ae	29.83ab	51.5a	140.5e-j	45.46hk
P2D2N4	2513.3ag	28.13af	23.16ch	107.83h-l	44.76cd
P2D3N1	2610ae	28.74af	25.16b-f	183.83c-f	60.76cd
P2D3N2	2523.3ag	29.67ab	25.5b-e	125f-k	61.3c-e
P2D3N3	2980a	29.93a	20.66c-h	468.5a	74.56a
P2D3N4	2080di	26.4gh	28.5b	179.83c-g	56.43d-g
P2D4N1	1745fj	27.63ah	12.66jl	66.33kl	63.9b-d
P2D4N2	2180bi	26.7fh	11 l	73.75kl	64.4a-d
P2D4N3	1810ej	26.7fh	15.83gl	82.33j-m	66.73a-d
P2D4N4	1423.3ij	26.93dh	16.5f-l	62lm	73.4ab

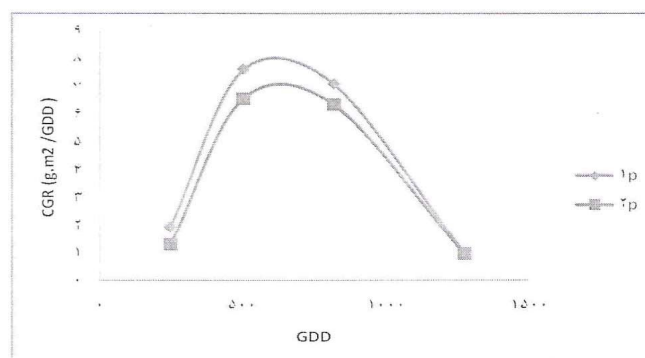


Fig 1: Comparison CGR Trend Planting pattern

Fig 1:

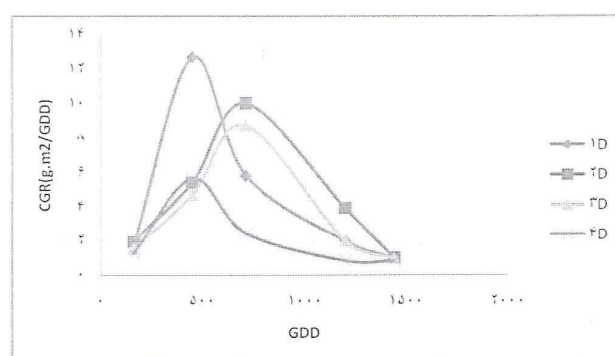


Fig 2: Comparison CGR Trend Planting date

Fig 2:

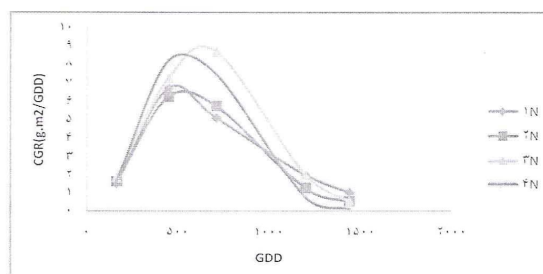


Fig 3: Comparison CGR Trend Nitrogen

Fig 3:



Table 5: Mean comparison of main effects

Treatment	15 day after planting gr.m <sup>2</sup> /GDD	30day after planting gr.m <sup>2</sup> /GDD	45 day after planting gr.m <sup>2</sup> /GDD	60 day after planting gr.m <sup>2</sup> /GDD
<b>P</b>				
P1	1.96a	7.62a	7.39a	1.7
P2	1.31b	6.58b	6.56a	1.34b
<b>D</b>				
D1	1.76b	12.67a	6.1c	1.14b
D2	1.95a	5.4b	10.47a	3.8a
D3	1.55 c	4.6c	8.58b	0.75c
D4	2.26d	5.6b	2.4d	0.54b
<b>N</b>				
N1	1.51b	6.7bc	5.8a	5.03a
N2	1.62b	6.25c	5.5a	0.62c
N3	1.83a	7.25b	8.5a	1.15b
N4	1.57b	8.19a	7.8a	0.5d
<b>P×D</b>				
P1D1	2.03b	13a	11.15b	2.33c
P1D2	2.34a	5.47c	8.4c	6.01a
P1D3	2.11b	5.2cd	8.21c	1.3f
P1D4	1.35de	6.81b	1.8c	0.2f
P2D1	1.5cd	12.35a	1.24e	-0.046f
P2D2	1.57c	5.36c	12.54a	1.77d
P2D3	1f	4.15d	8.59c	2.89b
P2D4	1.17ef	4.16cd	.52d	0.8e
<b>P×N</b>				
P1N1	1.65d	6.89bd	6.79bc	6.96a
P1N2	1.83c	7.66ac	6.06cd	-0.87f
P1N3	2.33a	7.87ab	7.51b	0.25e
P1N4	2.02b	8.07a	9.2a	0.85d
P2N1	1.83e	6.53d	4.94e	3.11b
P2N2	1.41e	4.84e	5.1ed	2.14c
P2N3	1.33e	6.63cd	9.65a	2.06c
P2N4	1.11f	8.32a	6.54bc	-1.92
<b>D×N</b>				
D1N1	1.26cd	11.9d	5.65d	-0.3h
D1N2	1.93b	8.76d	4.84de	0.92g
D1N3	1.93b	14.22b	8.62c	1.5f
D1N4	1.93b	15.82a	5.65c	2.1e
D2N1	1.88b	5.03fg	7.39c	11.12a
D2N2	1.95b	6.48ef	5.41d	5.62b
D2N3	2.05b	4.88fg	14.24a	0.9g
D2N4	1.9b	5.26eg	14.38a	-2.06i
D3N1	1.45b	5.47eg	8.45c	4.75c
D3N2	1.26cd	4.26g	7.36c	0.36h
D3N3	2.4a	4.15g	8.07c	0.08h
D3N4	1.11de	4.38fg	10.44b	-2.1i
D4N1	1.46c	4.44g	1.98gf	4.3d
D4N2	1.35cd	5.4eg	4.7de	-4.37j
D4N3	0.95e	5.74eg	3.4ef	2.1e
D4N4	1.28cd	6.68e	0.57g	-0.015h

Table 6: Mean comparison of main effects

Treatment	15 day after planting gr.m <sup>2</sup> /GDD	30day after planting gr.m <sup>2</sup> /GDD	45 day after planting gr.m <sup>2</sup> /GDD	60 day after planting gr.m <sup>2</sup> /GDD
P1D1N1	1.5hl	10.48e	15.13ac	1i
P1D1N2	2def	11.46de	9.8fh	0-8j
P1D1N3	2.16ce	15.91ab	8.2gj	2.46c
P1D1N4	2.46bc	14.56bc	11.5cf	6.4c
P1D2N1	1.83ei	4.42hl	5.46km	13.8a
P1D2N2	2.33cd	6.77fh	2.4n	8.86b
P1D2N3	2.43bc	5.2hk	12.8de	0.73i
P1D2N4	2.76b	5.48hk	12.93ce	0.76i
P1D3N1	0.8ej	6.4fi	6.43jl	8.64b
P1D3N2	1.43in	5.48hk	7.82hj	-4.33n
P1D3N3	3.86a	4.62hl	4.64kn	-4.33m
P1D3N4	1.36km	4.33hl	13.97bd	-6.4o
P1D4N1	1.46hm	6.26fi	0.15o	4.4e
P1D4N2	1.56gk	6.91fg	2.24 ln	-7.24p
P1D4N3	0.86o	5.75hj	2.42l-n	1i
P1D4N4	1.5hl	8.31f	-1.6o	2.56gh
P2D1N1	1.03no	13.31cd	-3.82o	-1.07jk
P2D1N2	1.86eh	6.06fj	0.056o	2.64gh
P2D1N3	1.7ej	12.53ce	9.04gi	0.47i
P2D1N4	1.4jn	17.48a	0.2o	-2.33l
P2D2N1	1.93eg	5.64hj	9.31fh	8.44b
P2D2N2	1.56fk	6.2fi	8.42gi	2.37h
P2D2N3	1.66fk	4.75hl	15.68ab	1.07i
P2D2N4	1.13l-o	5.04hj	16.72a	-4.8n
P2D3N1	1.1 lo	4.55hl	10.46fg	0.87i
P2D3N2	1.11lo	3.68kl	6.91ik	5.05d
P2D3N3	0.93o	3.69kl	11.51ef	3.5f
P2D3N4	1.46im	5.33hk	6.91ef	2.3h
P2D4N1	1.13lo	2.62l	3.01mn	4.2e
P2D4N2	1.03no	4.06il	5.15km	-1.15k
P2D4N3	1.06mo	5.7hj	2.37n	3.2fg
P2D4N4	0.93o	5.42hk	2.74n	-2.6l

Table 7: correlation index

	yield	Weight of 1000 seeds	Number of clusters in plant	Number of seeds in plant	Harvest index
yield	1				
Weight of 1000 seeds	0.099n.s	1			
Number of clusters in plant	0.58n.s	0.102**	1		
Number of seeds in plant	0.196n.s	-0.12**	0.136n.s	1	
Harvest index	-0.131n.s	0.06ns	-0.402**	-0.467	1

n.s. \*, \*\*: non significant at the 5%, 1% level of probability

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