



THE EFFECT OF MOTHER PLANT NITROGEN ON SEED VIGOR AND GERMINATION IN RAPESEED

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ABSTRACT

This experiment was conducted in laboratory and field to evaluate the effect of top-dress nitrogen fertilizer application in mother plant of rapeseed on germination and vigour of produced seeds. The field test was conducted in factorial on the basis of complete randomized block design in three replications. The treatments consist of top-dressing nitrogen fertilizer in three levels of 0, 50 and 100 kg/ha that exerted on mother plant and cultivar in six level including Talaieh, SLM046, Okapi, Orient, locord and Zarfam and the emergence rate, mean emergence time and seedling emergence percentage were measured. Studied factors in laboratory were standard germination, mean germination time, coefficient of velocity of germination and electrical conductivity test. Field tests results showed that the effect of cultivar, top-dressing nitrogen fertilizer application and the interaction effect of cultivar and top-dressing fertilizer on emergence rate, mean emergence time and field emergence percentage was significant and the highest rate of emergence, the lowest amount of mean time for emergence and the highest percentage of field emergence were for cultivar of Zarfam and application of 100 kg/ha top-dress nitrogen fertilizer in mother plant. The lab results also showed that standard germination of seeds was not affected by application of different levels of nitrogen fertilizer but the effect of cultivar, top-dressing fertilizer and interaction of cultivar and top-dressing fertilizer on mean time for germination, coefficient of velocity of germination and electrical conductivity was significant. The highest mean time for germination observed in no-fertilizer application treatment and the lowest was in 100 kg/ha treatment. Cultivar of Okapi had the highest mean time for germination in all levels of nitrogen fertilizer application. The highest amount of coefficient of velocity of germination was in cultivar of Zarfam and 100 kg/ha application of top-dressing nitrogen fertilizer and the lowest amount was in cultivar of Okapi without top dress fertilizer application. Electrical conductivity test results also indicated the highest amount of exudation from seed in cultivar of Talaieh and without nitrogen fertilizer application in mother plant and the lowest amount in cultivar of Zarfam with 100kg/ha application of nitrogen fertilizer in mother plant. The regression results of electrical conductivity and measured characters in field conditions showed that electrical conductivity has significant correlation with all measured indexes in field and this test could apply for determining seedling emergence percentage and seedling establishment in field.

Keywords: rapeseed, emergence rate, fertilizer application, seed vigour, germination, electrical conductivity.

INTRODUCTION

In modern agriculture in many countries farmers try to produce high quality and uniform products with minimum costs (Gary, 1983). To achieve this objective fast and uniform seedling establishment is necessary which needs having high quality seeds (Hadavizadeh and Raymond, 1989). Seed quality affected by several factors and seed germination, vigor and health assessment has an important role in determination of seed quality (Perry, 1980).

Seed vigor is an important factor that affects seedling establishment and crop growth and ultimately production rate. Each biotic or non biotic factor that affect seed vigor and germination during seed's development, subsequently will affect production especially when seeds produced under stress condition (Zakaria, 2009).

Seed vigor and germination ability directly affect yield and seed quality also affect seedling emergence (Tekrony and Egli, 1991) as seed lots with high vigor show high final emergence compare to seed lots with low vigor (Johnson and Wax, 1981).

Experiments on wheat seeds with uniform size but different nitrogen concentration have shown higher amount of protein content which may produce vigorous

seedlings but this not always become true (Rahman and Goodman, 1983).

Environmental conditions affect seed quality during seed formation and therefore have effect on seedling establishment in the next growing season (Zakaria *et al.*, 2009).

Environmental conditions especially soil nitrogen affect seed's nitrogen content and sometimes increase or decrease yield and yield components.

Nitrogen play key role in seed filling (Green, 1984). Nitrogen application causes crop leaf area increasing that may increase dry matter by more light absorption (Willhelm, 1998).

Nitrogen fertilizer increased seed's protein content in wheat (Knowles *et al.*, 1991) that is a good index for seed quality and vigor, as by application of nitrogen fertilizer in wheat, seeds had higher final germination percentage while the time that 50% of seeds germinated and mean germination time significantly decreased (Warraich, *et al.*, 2002) and seeds with application 120 kg/h nitrogen fertilizer had more vigor compare to 0-60-180 kg/h in electrical conductivity test.

Researches showed if mother plants undergo high temperature stress physiological disorders will induce in



seeds which are along with germination delay, decrease of seedling growth and emergence and also low yield in field (Mattews and Powel, 1987) (Perry and Harrison, 1973).

Studies on sunflowers showed that high germination in sunflower is gained by using 120 kg/h nitrogen fertilizer (Sawan, *et al.*, 1985) (Maheswarappa, 1985). Some reports also are remarkable that application of 0-200-400-600 kg/h nitrogen fertilizer has no effect on seed vigor and germination percentage (Osechas and Torres, 2002).

High application of nitrogen fertilizer in pea resulted in decreased yield and germinating ability (Pollock and, 1972).

Positive effect of nitrogen fertilizer in mother plant can attribute to it's role in delaying aging cycle and providing enough time to obtain photosynthetic matters and so more weigh and higher quality (Delouch, 1980), (Pallais, *et al.*, 1987).

The purpose of this experiment is assessment of top-dressing nitrogen fertilizer application in mother plant of some fall rapeseed cultivars on germination and vigor of resulted seed.

MATERIALS AND METHODS

This experiment was conducted in laboratory and farm in Seed and Plant Registration and Certification Institute in Karaj - Iran in 2006-2007.

Farm test

Farm soil was loam-clay and soil pH was 7.5-7.8. Test was conducted in farm as factorial on the basis of complete randomized block design in three replications.

Treatments were top-dressing nitrogen fertilizer in 3 levels 0, 50 and 100 kg/h which exerted on mother plant; cultivar was in 6 levels including Talaieh, SLM046, Okapi, Orient, Licord and Zarfam. Each block consisted of 18 experimental plots and each experimental plot had 2 rows of 2 meter length with 60 centimeter width which on each row considered 2 planting line with 30 centimeter space. Seed quality in planting line was considered 100 plants in each square meter. During field preparation, 100 kg urea, 100 kg super potassium sulfate and 150 kg ammonium phosphate was added to soil.

Consider to the first irrigation date as planting date, after 7 days the seed vigor related indexes including daily emergence rate, emergence velocity coefficient,

mean emergence time, field emergence percentage were obtained.

$$\text{Emergence rate} = \frac{\text{Final emergence percentage}}{\text{The days reaching maximum emergence}}$$

$$\text{Mean germination time} = \frac{\text{Number of germinated seeds during test days}}{\text{Total number of germinated seed}}$$

$$\text{Seedling emergence percentage} = \frac{\text{Number of germinated seeds} * 100}{\text{Number of planted seeds}}$$

Laboratory stage

a) Standard germination: 3 replications of 100 seeds were selected from each sample in laboratory, samples were placed between paper as towel method in germination with 76-86% moisture and 20°C temperature. After 7 days the number of normal and abnormal seedlings, decayed and un-germinated seeds was counted.

b) Mean germination time (MGT): Mean germination time which is considered as germination velocity and acceleration index was obtained from below relation (Ellis and Roberts, 1981):

$$\text{MGT} = \frac{\sum (nd)}{\sum n}$$

n = number of germinated seed during d days

d = number of days

$\sum n$ = total number of germinated seeds

c) Coefficient of velocity of germination (CVG): This index represents seed germination acceleration which obtained from below relation (Scott *et al.*, 1984):

$$\text{CVG} = \frac{1}{\text{MGT}}$$

Data were analyzed by SAS software means were compared by Duncan test in level of 5%.

RESULTS AND DISCUSSIONS

Field results

Daily emergence rate: Variance analysis results showed that main effects of cultivar and top-dressing nitrogen fertilizer on emergence rate are significant also the interaction of nitrogen top-dressing fertilizer and cultivar is significant for daily emergence property (Table-1).

Table-1. Mean squares of some measured characters in field condition.

s. o. v	df	Daily emergence rate	Mean emergence time	Field emergence percentage
replication	2	0.001 ^{ns}	0.135 ^{ns}	15.130 ^{ns}
Nitrogen top-dressing fertilizer	2	0.009 ^{**}	2.698 ^{**}	236.574 ^{**}
Cultivar	5	0.005 ^{**}	1.005 ^{**}	105.052 ^{**}
Nitrogen top-dressing fertilizer*cultivar	10	0.002 ^{**}	16.505 ^{**}	21.485 ^{**}
Error	34	0.001	0.601	6.796
c. v		3.49	11.17	3.23

ns = non significant; * : significant in 5% level; **: significant in 1% level



The survey of mean comparison results for nitrogen top-dressing fertilizer and cultivar showed that the highest amount of daily emergence was related to cultivar of Zarfam with mean of 0.0786 with application of 100 kg/h nitrogen top-dressing fertilizer. Also the lowest amount of emergence was related to seeds without top-dressing fertilizer and the difference of studied cultivars in this fertilizing level was not significant (Figure-1).

It's considerable that in all cultivars with increasing nitrogen top-dressing fertilizer, daily emergence rate increases. Since the daily emergence rate shows the days for individual seed emergence therefore with increasing nitrogen top-dressing fertilizer the number of days for individual seed emergence decreases so the emergence speed increases.

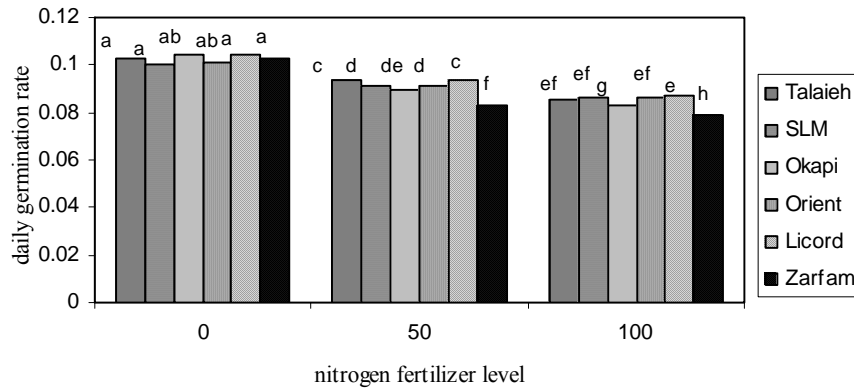


figure 1: Interactive effect of nitrogen top-dressing fertilizer and cultivar on daily germination rate in field condition

Mean emergence time

Regarding variance analysis results, it's observed that nitrogen top-dressing fertilizer and cultivar effects and either nitrogen top-dressing fertilizer and cultivar interaction on mean emergence time is significant in 5% level (Table-1). Considering results of mean comparison of nitrogen top-dressing fertilizer and cultivar interaction it's noticeable that the maximum germination time was related to seeds without application of nitrogen top-dressing fertilizer in mother plant. Moreover there wasn't any significant difference between cultivars in this fertilizing level. Also the lowest germination time is for cultivar of Zarfam with mean of 1.424 and application of

100 kg/h nitrogen top-dressing fertilizer in nutrition of mother plant. When 50 kg/h top-dressing nitrogen fertilizer was applied for mother plant nutrition, cultivar of Zarfam had the lowest mean time and there wasn't any significant difference between other cultivars.

It's considering with increasing application of nitrogen top-dressing fertilizer in mother plant, mean emergence time decreases in all cultivars, the reason can attribute to increase of daily emergence rate. Studies by Wanjoura (Wanjoura *et al.*, 1969) on cotton are emphasizing the effect of seed quality on decreasing germination time.

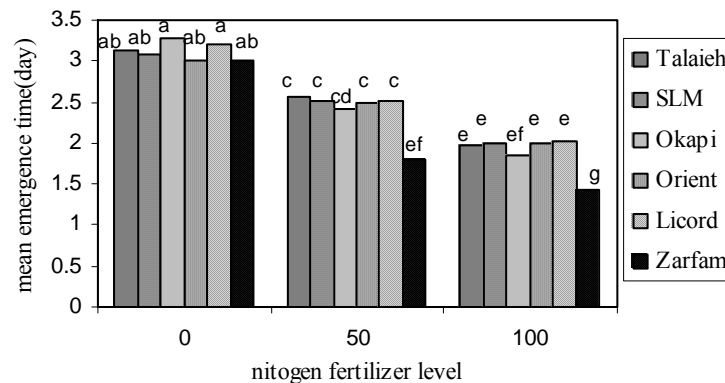


figure 2: interaction of nitrogen top-dressing fertilizer and cultivar on mean germination time in field condition



Field emergence percentage

Variance analysis results show significant difference in field emergence among different levels of top-dressing nitrogen fertilizer in 1% level. Also the difference of emergence between cultivars and also its interactive effect with nitrogen top-dressing fertilizer on field emergence is significant in level of 1% (Table-1).

Regarding results comparison of nitrogen top-dressing fertilizer and cultivar interaction it's observed that the highest percentage of field emergence is for cultivar of Zarfam with mean of 89 germinated seed and 100 kg/h nitrogen top-dressing fertilizer application which showed significant difference to other cultivars in this fertilizing level. Also the lowest percentage of field emergence was for cultivars of Okapi and Licord with mean 67 germinated seed which had no statistical difference with cultivars of Talaieh and Zarfam but had significant difference with cultivars of SLM and Orient.

When 50 kg/h nitrogen top-dressing fertilizer used for seed production the difference of emerged seeds of studied cultivars in this fertilizing level wasn't significant except of Zarfam cultivar which had the highest emergence percentage (84 percent).

As it's observed with increasing application of top-dressing nitrogen fertilizer the field emergence percentage increases in all cultivars because increasing protein content induces faster seeds emergence that results in more and better use of water and nutrients and also root development which can be an important factor for increasing field emergence. With more application of nitrogen fertilizer in sunflower the emergence percentage increases (Maheswaappa, 1985).

The same result has been reported with 90 kg/h phosphorus fertilizer application in sunflower (Maheswarappa, 1985).

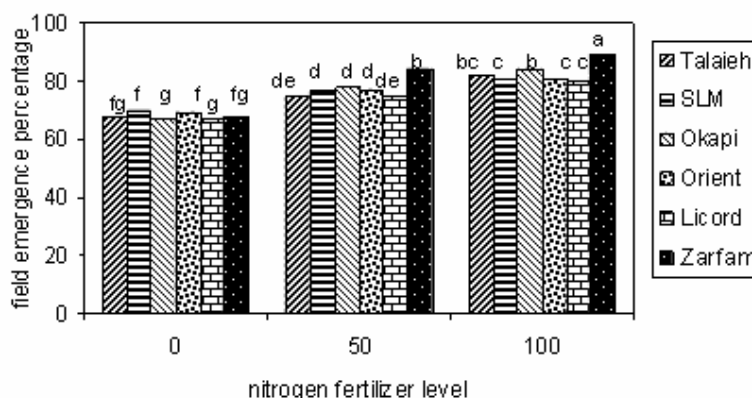


figure 3: nitrogen top-dressing fertilizer and cultivar interaction on field emergence

Laboratory results

Vigor

The results of variance analysis show that vigor wasn't affected by different levels of nitrogen fertilizer also top-dressing nitrogen fertilizer and cultivar interaction

didn't affect seeds vigor but cultivar had significant effect on vigor at level of 5% (Table-2) as the highest amount of vigor belonged to Zarfam and Licord with means of 98/56 and 98/22 and the lowest amount of vigor belonged to cultivar of Talaieh with means of 92 percent.

Table-2. Mean square of some measured characters in standard germination test.

s. o. v	df	vigor	Coefficient of velocity of germination	Mean germination time	Electrical conductivity
Nitrogen fertilizer	2	10.979 ^{n.s}	0.200 ^{**}	0.269 ^{**}	21.225 ^{**}
cultivar	5	26.828 ^{**}	0.107 ^{**}	0.153 ^{**}	12.074 ^{**}
Cultivar*fertilizer	10	9.578 ^{n.s}	0.018 ^{**}	0.045 ^{**}	2.21 ^{**}
error	26	9.15 ^{n.s}	0.004	0.013	0.698
cv		3.15	8.36	8.92	3.79

n. s = non significant; *: significant in 5% level; **: significant in 1% level



Mean germination time

Variance analysis results show statistical difference between levels of nitrogen top-dressing fertilizer and cultivars and also interaction of nitrogen top-dressing fertilizer and cultivar in 1% level (Table-2).

Regarding the results of mean comparison, the highest mean germination time was for no application of nitrogen top-dressing fertilizer treatment moreover there wasn't significant difference among cultivars and the lowest mean germination time was related to 100 kg/h top-dressing fertilizer treatment but there wasn't any significant statistical difference between cultivars except of Okapi (Figure-4). In no application of nitrogen top-

dressing fertilizer treatment, the cultivar of Okapi had the highest mean germination time with mean of 2.000 and cultivar of Zarfam with mean of 1.423 had the lowest amount. The reason of Zarfam prevalence to other cultivars can refer to that the seeds obtain maximum germination at fewer days.

Ellis and Robert (Ellis and Roberts, 1981) confirmed seed lots with high germination rate and vigor have lower mean germination time.

Application of 180 kg/h nitrogen fertilizer in wheat resulted in decreasing mean germination time (Anderson and Bergts, 1989).

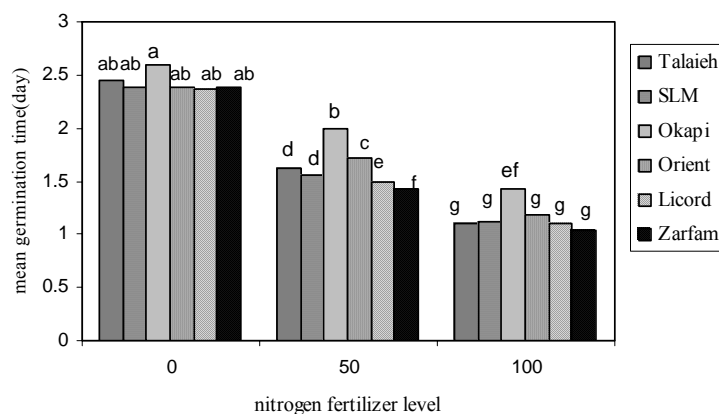


figure 4: interaction of cultivar and top-dressing fertilizer on mean germination time

Coefficient of velocity of germination

Variance analysis results show significant effect of nitrogen top-dressing fertilizer, cultivar and the interaction of nitrogen top-dressing fertilizer and cultivar on germination rate and mean comparison showed that the highest coefficient of velocity of germination was for cultivar of Zarfam with mean of 0.9596 in treatment of 100 kg/h nitrogen top-dressing fertilizer application and the lowest coefficient of velocity of germination was in Okapi cultivar (0.3844) without application of nitrogen top-dressing fertilizer (Figure-5). In treatment of 50kg/h

nitrogen top-dressing fertilizer application, cultivar of Zarfam with 0.7027 had the highest and cultivar of Okapi with 0.5000 had the lowest amount of coefficient of velocity of germination. As its seen cultivar of Zarfam had the highest amount of coefficient of velocity of germination because of the lowest amount of mean germination time (1.042).

Scott and his colleagues (Scott *et al.*, 1984) reported that if seeds germinate faster and their vigor is higher, the coefficient of velocity of germination increases.

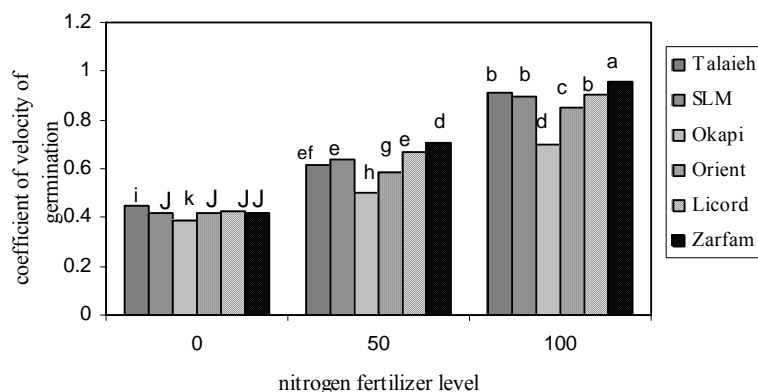


figure 5: Interaction of cultivar and nitrogen fertilizer on coefficient of velocity of germination



Electrical conductivity test

Regarding the variance analysis results, nitrogen top-dressing fertilizer, cultivars and also interaction of nitrogen top-dressing fertilizer and cultivar had significant difference on seed's electrical conductivity at 1% level (Table-2).

Considering mean comparison results of nitrogen top-dressing fertilizer and cultivar interaction it detected the highest amount of electrical conductivity was for seeds of cultivar of Talaieh with 27.93 $\mu\text{cm/g}$ mean when nitrogen top-dressing fertilizer didn't use for seeds production and the lowest amount of electrical

conductivity was for cultivar of Zarfam and application of 100kg/h top-dressing fertilizer (20.83 $\mu\text{cm/g}$) (Figure-6).

As it's observed in no application of fertilizer treatment, the cultivar of Talaieh with mean of 27.93 $\mu\text{cm/g}$ has the highest amount of electrical conductivity and cultivars of Zarfam and Okapi have the lowest amount. When 50 kg/h nitrogen top-dressing fertilizer applied, the cultivar of Talaieh with mean of 25.80 $\mu\text{cm/g}$ had the highest amount of electrical conductivity and cultivars of Zarfam and Okapi with means of 21.48 and 21.45 $\mu\text{cm/g}$ had the lowest amount.

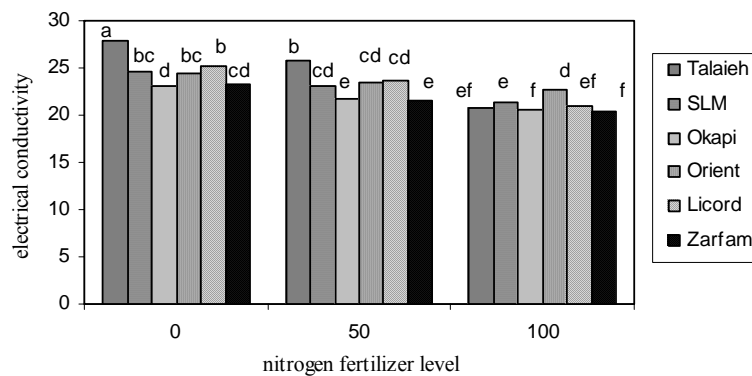


figure 6: Interaction of cultivar and nitrogen fertilizer on electrical conductivity

According to results the amount of permeability of membrane's wall in 100 kg/h nitrogen top-dressing fertilizer application in all cultivars had the significant decline compare to other two fertilizing level and it can be the important factor in increasing of field emergence and seed vigor in this fertilizing treatment.

Powell and Colleagues, Matthews and Powell and Matthews and Bradnock experiments has proved that there

is a closed relation between electrical conductivity of exuded matters from seed and seed vigor.

In experiment was done on wheat by Ahmad and Basra (70) it's reported the amount of matter exudation from seed membrane decreased with 120 kg/h nitrogen top-dressing fertilizer compare to lower amount of nitrogen fertilizer application.

Table-3. The correlation of lab tests with field measured indexes.

Farm standard germination test	Emergence rate	Mean germination time	Field emergence percentage
Germination	0.089 ^{ns}	-0.104 ^{ns}	0.053 ^{ns}
Coefficient of velocity of germination	0.090 ^{ns}	-0.357 ^{**}	0.078 ^{ns}
Mean germination time	0.078 ^{ns}	-0.309 ^{**}	0.086 ^{ns}

Totally according to above table it's deduced that standard germination test can't be used to predict field

emergence. Ram and Colleagues researches (1989) on pea plant prove this opinion.

Table-4. Electrical conductivity correlation with field measured indexes.

farm Seed vigor test	Emergence rate	Mean germination time	Field emergence percentage
Electrical conductivity	0.401 ^{**}	0.328	-0.357

* : significant in 5% level; **: significant in 1% level



According to correlation results of electrical conductivity test and measured characters in field condition, electrical conductivity test has important negative correlation with all measured indexes in field and this test can be used for determining of seedling emergence percentage and seedling establishment in field. The research results are emphasizing these experiments results (Mattews and Powel, 1978).

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