Asian Journal of Chemistry Vol. 19, No. 4 (2007), 3178-3184

Relationships Among Electrical Conductivity of Seed Leakage, Germination, Field Emergence Percentage and Some Seed Traits in Faba Bean (*Vicia faba* L.)

ERKUT PEKSEN
Department of Field Crop, Faculty of Agriculture
Ondokuz Mayis University, 55139 Samsun, Turkey
Fax: (90)(362)4576034; Tel: (90)(362)3121919; E-mail: erkutp@omu.edu.tr

This study was carried out to investigate the relationships among electrical conductivity (EC) of seed leakage at both 24th and 48th h, germination speed (GS), germination power (GP), field emergence percentage (FE) and some seed traits such as water absorption rate (WAR) of seeds during imbibition and seed coat ratio (SCR) in 15 faba bean (*Vicia faba* L.) cultivar/population. The results of the present studies revealed that faba bean cultivar/population differed for all investigated traits ($p < 0.01$). EC of seed steep water at 24th h showed similar trend to EC values determined at 48th h. EC ranged from 7.9 to 12.1 µS cm^{-1} g^{-1} at 24th h and 10.1 to 18.1 µS cm^{-1} g^{-1} at 48th h. In all cultivar/populations, the amount of water absorbed by the seeds at the end of the 24 h exceeded their initial dry weights. EC readings, at both 24th and 48th, didn't give strong and reliable relationships to predict GS, GP and FE. Positive relationships were found between SCR and EC ($r = 0.390$** and $r = 0.452$** for 24th and 48th h, respectively) and WAR ($r = 0.336$*).

Key Words: Faba Bean, *Vicia faba*, Germination, Seed coat ratio, Electrical conductivity, Water absorption rate, Field emergence.

INTRODUCTION

Changes in seed quality have important effects on emergence and seedling and plant development stages[1]. For successful agricultural production, first step is to use seeds with high yield potential and high quality. A big part of the success of a farmer's crop depends on the quality of seed. Other agricultural inputs such as fertilizers, pesticides, herbicides and overall crop management also help to realize the production potential of seeds[2]. The components of seed quality include genetic and mechanical purity, seed germination and vigour and seed health testing[3].

Germination test results can be used to compare the quality of different seed lots[4]. Although, it is the most common and practical seed viable test, the germination percentage indicates only the potential of a seed lot to establish seedlings under controlled conditions. Germination test can't reflect seed vigour potential completely under stressful conditions. Seed lots with a higher germination capacity will always prove to establish more seedlings than those with a lower germination capacity, especially under suboptimal conditions[5].

Some tests such as tetrazolium, seedling growth rate and seedling dry weight, accelerated aging test, first count, speed of germination, cool germination test and cold test are used to estimate seed vigour[6]. Electrical conductivity test termed as the bulk conductivity test, which is now extensively used in Europe, Australia and New Zealand for garden pea (*Pisum sativum* L.)[7]. Seed vigour may be reduced by damage to the embryo or seed coat during harvesting and processing. Discrepancies between germination capacity and field performance are not equal in different species. In pulses, for instance, discrepancies occur much more commonly than in cereals[5].

As seeds age, the seed membrane becomes more permeable, so many substances in seeds such as sugars, free amino acids, organic acids and various elements leach out in the presence of water. The concentration of leakages is normally measured either by the electrical conductivity or by chemical methods. It was determined that leaching of sugars was related to the total soluble sugars present in seeds[6]. The integrity of cell membranes, as determined by deteriorative biochemical changes, the ability to reorganize and repair damage and/or physical disruption, can be considered to be the 4 fundamental causes of the differences in seed vigour which are indirectly measured as electrolyte leakage during the conductivity test[8-10]. Seed lots with high laboratory germination yield large quantities of electrolytes following soaking are rated as being low in vigour and consequently seed lot performance is likely to be poor under stressful conditions. Conversely, high germinating seed lots with low electrolyte leakage are considered to be high in vigour and better able to withstand stressful conditions[11]. Symptoms of vigour loss are reductions in germination rate and uniformity, reductions in tolerance to environmental stress and inferior seedling emergence and growth[12].

The object of this study was to investigate the relationships among electrical conductivity of seed steep water, water absorption rate during imbibition, seed coat ratio, germination speed and power and field emergence percentage in faba bean (*Vicia faba* L.).

EXPERIMENTAL

10 Local populations collected from some districts and villages of Samsun, Amasya, Sinop and Tokat provinces of Turkey, two lines from ICARDA and three cultivars used in the study. 15 Faba bean cultivar/ populations used in the study are given in Table-1.

TABLE-1
FABA BEAN CULTIVAR/POPULATIONS AND THEIR COLLECTION SITES

Cultivar/populations	Collection sites
1.Vezirkopru-1	Vezirkopru/Samsun
2.Vezirkopru-2	Vezirkopru/Samsun
3.Sinop	Sinop
4.Yenice	Yenice/Amasya
5.Merzifon	Merzifon/Amasya
6.Avren	Avren-Merzifon/Amasya
7.Gemenez	Gemenez- Merzifon/Amasya
8.Seyhyeni	Seyhyeni-Merzifon/Amasya
9. Lara	May-Agro Seed Company /Bursa
10. FLIP 86-116FB	ICARDA
11. FLIP 85-172FB	ICARDA
12. Eresen-87*	Aegean Agricultural Research Institute, Menemen/Izmir
13. Filiz-99*	Aegean Agricultural Research Institute, Menemen/Izmir
14.Gumushacikoy	Gumushacikoy/Amasya
15.Turhal	Turhal/Tokat

*Registered by Aegean Agricultural Research Institute, Menemen/İzmir

The electrolytes leaking from seeds into the seed soaking water were measured at the end of the 24th and 48th h using the electrical conductivity (EC) test method described by Hampton *et al.*[13]. To determine the water absorption rate (WAR), 50 seeds with 3 replications were soaked in distilled water at 20°C for 24 h. Then, they were removed from the distilled water and surface dried. WAR was calculated using the following equation;

Water Absorption Rate (WAR) (%) = 100 (a-b)/b
a: weight (g) of seeds after soaking in distilled water at 20°C for 24 h
b: initial dry weight (g) of seed sample

Seed coats of soaked 3 × 50 seeds were removed from cotyledons by hand. Dry weights of testa and cotyledonary tissue were determined by drying in an oven at 80°C for 24 h. Seed Coat Ratio (SCR) was expressed as a percentage of dried whole seed weight[14]. Germination speed (GS) and germination power (GP) percentages were determined using the ISTA method[15,16]. The field emergence (FE) was tested for three replicates of 100 seeds in a randomized complete block design. Seeds were sown in 4-5 cm soil depth by hand in 4 row plots with 50 cm between the rows and 20 cm between plants, on November 18, 2005 in Samsun, Turkey. FE was recorded as the number of seedling emerged from the soil at the end of the 21st day after sowing. All statistical analyses were conducted with the MSTATC programme. Means showing statistical significance were compared using LSD test.

RESULTS AND DISCUSSION

Highly significant differences were found among faba bean cultivar/ populations in terms of all traits. Means for seed leakage electrical conductivity, water absorption rate, seed coat ratio, germination speed and power percentages and field emergence percentages belong to 15 faba bean cultivar/populations are presented in Table-2.

TABLE-2
MEANS OF FABA BEAN CULTIVAR/POPULATIONS FOR EC, WAR, SCR, GS, GP AND FE

Cultivar / populations	EC at 24 h (µS cm^{-1} g^{-1})	EC at 48 h (µS cm^{-1} g^{-1})	WAR (%)	SCR (%)	GS (%)	GP (%)	FE (%)
1.Vezirkopru-1	10.3a-d†	16.1a-d†	125.3ab†	15.5bcd†	86.7abc†	100.0a†	84.0ab†
2.Vezirkopru-2	10.7abc	16.5abc	132.6a	16.7a	61.3e	94.7ab	84.0ab
3.Sinop	10.8abc	17.2ab	125.3ab	15.3b-e	81.3bc	92.0b	86.7ab
4.Yenice	9.4cde	13.3c-f	120.5bc	15.9abc	93.3ab	100.0a	90.7ab
5.Merzifon	12.1a	18.1a	114.7c	15.2cde	89.3abc	100.0a	89.3ab
6.Avren	10.8abc	14.8a-e	122.9bc	15.6bcd	97.3a	100.0a	85.3ab
7.Gemenez	9.6b-e	12.6def	126.5ab	15.4bcd	77.3cd	100.0a	85.3ab
8.Seyhyeni	10.7abc	16.5abc	123.5abc	16.8a	66.7de	97.3ab	86.7ab
9.Lara	7.9e	10.1f	126.3ab	14.9def	82.7bc	100.0a	93.3a
10.FLIP 86-116FB	8.7de	11.3ef	121.4bc	14.7d-g	93.3ab	100.0a	88.0ab
11.FLIP 85-172FB	9.3cde	12.3ef	121.3bc	13.9g	97.3a	100.0a	84.0ab
12.Eresen-87	9.6b-e	13.3c-f	124.3ab	14.4efg	80.0c	100.0a	88.0ab
13.Filiz-99	9.5b-e	13.5b-f	126.7ab	14.2fg	84.0bc	97.3ab	81.3b
14.Gumushacikoy	10.1bcd	12.4def	127.0ab	15.6bcd	65.3de	92.0b	86.7ab
15.Turhal	11.3ab	18.1a	128.3ab	16.3ab	77.3cd	100.0a	80.0b

†Significant at 0.01 level, means followed by the same letters within the same column are not significantly different according to LSD Test.

Faba bean cultivar/populations were differed for EC values at both 24th and 48th h ($p < 0.01$). EC readings varied from 7.9 µS cm^{-1} g^{-1} in Lara to 12.1 µS cm^{-1} g^{-1} in Merzifon at 24th h and 10.1 µS cm^{-1} g^{-1} in Lara to 18.1 µS cm^{-1} g^{-1} in Merzifon and Turhal at 48th h. EC readings at the 24th h showed similar trend to 48th h readings (Table-2 and Fig. 1). When EC readings at 24th h took into consideration, except for Merzifon, seeds of all faba bean cultivar/populations had high vigor and their seeds were suitable for sowing in cold and wet soil conditions according to a practical conductivity test scale developed by Kantar and Hebblethwaite[17].

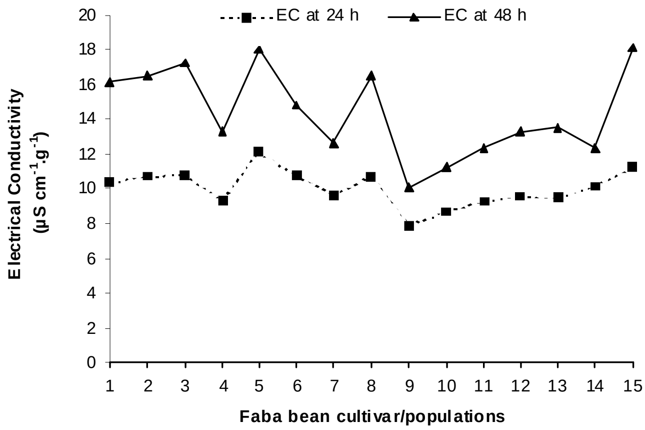

Fig. 1. Seed leakage electrical conductivity (EC) of faba bean cultivar/populations at the end of the 24th and 48th hour

Significant differences ($p < 0.01$) were found among faba bean cultivar/populations for WAR (Table-2). The amount of water absorbed by the seeds at the end of the 24 h exceeded their initial dry weights. Vezirkopru-2 had the highest WAR (132.6 %) while Merzifon had the lowest (114.7 %). SCRs determined in Seyhyeni (16.8 %) and Vezirkopru-2 (16.7 %) were significantly higher ($p < 0.01$) than that in the others. FLIP 85-172FB line had the lowest SCR (13.9 %) (Table-2 and Fig. 2).

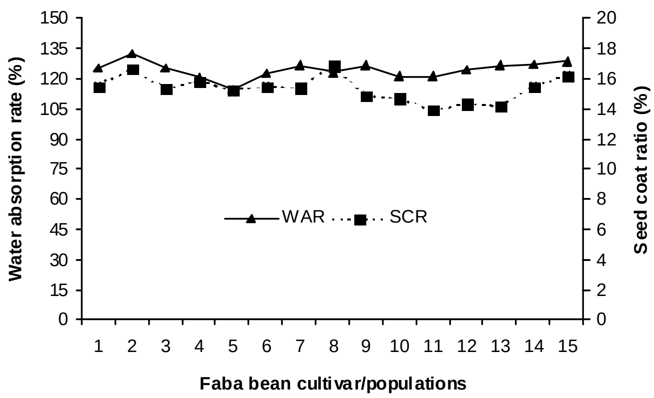

Fig. 2. Changes of water absorption (WAR) and seed coat rate (SCR) regarding faba bean cultivar/populations

Analysis of variance revealed that the differences among faba bean cultivar/populations for GS, GP and FE were significant ($p < 0.01$). GS was found between 61.3 and 97.3 % while GP were between 92.0 % and 100.0 %. FE was lower when compared to GP percentages and over 80 %. Although Filiz-99 and Turhal gave lower FE values than the others, the rest of the faba bean cultivar/populations were not different from each other regarding FE (Table-2 and Fig. 3).

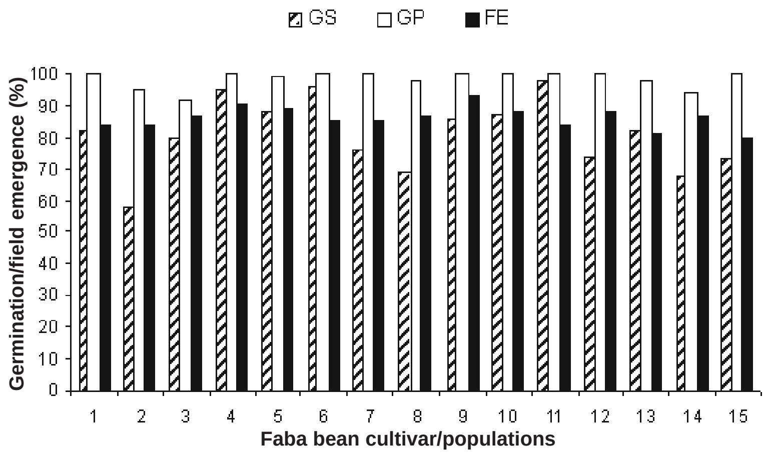

Fig. 3. Germination speed (GS), germination power (GP) and field emergence (FE) percentages of faba bean cultivar/populations

Correlation among electrical conductivity, water absorption rate, seed coat rate, germination speed, germination power and field emergence percentages of faba bean cultivar/populations used in the study are presented in Table-3.

TABLE-3
CORRELATIONS DATA AMONG EC, WAR, SCR, GS, GP AND FE

	EC at 48 h	WAR	SCR	GS	GP	FE
EC at 24 h	0.908**	0.020	0.390**	-0.186	-0.199	-0.193
EC at 48 h	-	0.079	0.452**	-0.214	-0.181	-0.188
WAR	-	-	0.336*	-0.427**	-0.135	-0.154
SCR	-	-	-	-0.469**	-0.082	0.074
GS	-	-	-	-	0.456**	0.145
GP	-	-	-	-	-	0.034

*: Significant at 0.05 level, **: Significant at 0.01 level.

SCR showed positive correlation with EC at both 24th h (r = 0.390**) and 48th h (r = 0.452**) and WAR (r = 0.336*). There were no significant correlation between EC and GS, GP and FE. GS negatively correlated with WAR (r = -0.427**) and SCR (r = -0.469**). Peksen *et al.*[18] reported that correlation between electrical conductivity and field emergence in coloured cowpea genotypes was not significant. They also determined that EC is an important test to predict field emergence potential of white seeded cowpea genotypes under field conditions. Pea cultivars with high seed coat ratio gave lower electrical conductivity values than lower ones and their laboratory germination percentages were significantly higher. Electrical conductivity values showed negative and highly significant correlation with laboratory germination and field emergence percentages. It was also found that emergence periods were prolonged with increases in electrical conductivity values[19]. In another study conducted by Palabiyik and Peksen[20] on the effects of seed storage periods on seed viability, seed yield and yield related characteristics in some common bean (*Phaseolus vulgaris* L.) cultivars, highly significant relationships were found between EC values and germination speed (r = -0.9316**), germination power (r = -0.9186**) and field emergence (r = -0.7660**).

Present study results revealed that EC test results were not related to germination speed, germination power and field emergence percentages in faba bean cultivar/populations used in the study.

REFERENCES

1. I. Demir, R. Yanmaz and A. Gunay, *Bahce*, **23**, 59 (1994).
2. J.P. Srivastava, in eds.: J.P. Srivastava and L.T. Simarski, Seed Production Technology, ICARDA, Aleppo, Syria, p. 1 (1986).
3. M.B. McDonald, *Seed Sci. Res.*, **8**, 265 (1998).
4. ISTA, *Supplement to Seed. Sci. Technol.*, **21**, 1 (1993).
5. W.J. van der Burg, in eds.: J.P. Srivastava and L.T. Simarski, Seed Production Technology, ICARDA, Aleppo, Syria, pp. 82-87 (1986).
6. P.K. Agrawal, in eds.: J.P. Srivastava and L.T. Simarski, Seed Production Technology, ICARDA, Aleppo, Syria, pp. 190-198 (1986).
7. J.G. Hampton and P. Coolbear, *Seed Sci. and Technol.*, **18**, 215 (1990).
8. H.M. Brouwer and J.C. Mulder, *J. Seed Technol.*, **7**, 84 (1982).
9. A.A. Powell, *Adv. Res. Technol. Seeds*, **11**, 29 (1988).
10. K.W. Duczmal and L. Minicka, *Acta Hortic.*, **253**, 239 (1989).
11. J.G. Hampton, in eds.: J.G. Hampton and D.M. TeKrony, International Seed Testing Association, Zurich, Switzerland, pp. 10-27 (1995).
12. J.G. Hampton, Seed vigour: Its importance and application. http://www.nzsti.semec.ws/semec/seedvigourintroduction.htm. (2000).
13. J.G. Hampton, K.A. Johnstone and V. Eua-umpon, *Seed Sci. Technol.*, **20**, 677 (1992).
14. F. Kantar, (B.Sc., M.Sc. Thesis), Univ. Nottingham, Leicester, England, p. 203 (1992).
15. ISTA, *Seed Sci. Technol.*, **13**, 299 (1985a).
16. ISTA, *Seed Sci. Technol.*, **13**, 356 (1985b).
17. F. Kantar and P.D. Hebblethwaite, in: Ire Conference Europanne Sur Les Proteagineux, Angers, France, pp. 213-214 (1992).
18. A. Peksen, E. Peksen and H. Bozoglu, *Pak. J. Bot.*, **36**, 311 (2004).
19. E. Peksen, A. Peksen, H. Bozoglu and A. Gulumser, *J. Agron.*, **3**, 243 (2004).
20. B. Palabiyik and E. Peksen, M.Sc. Thesis, p. 72 (2006).

(*Received*: 13 November 2006; *Accepted*: 30 January 2007) AJC-5376