Evaluation of Seed Viability and Vigor of Oilseed Rape (*Brassica napus* L.) under Different Seed Moisture Content at Harvesting Time

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INTRODUCTION

Seed is considered as approaching factor of yield potential in respect of quantitative and qualitative production (Agrawal, 1980). Harvesting too early may result in low yield and seed quality, decrement of viability and seed germination whereas harvesting too late may result in shattering and reduced seed yield (oplinger *et al*., 1989). Since the proper period for harvesting oil-seed rape is short, therefore identification of the harvest time is very important. It was recorded that the harvest maturity is a stage that physiological maturity has been ended and the SMC has decreased and seeds are suitable for harvesting. In the other hand it should be noticed that delay at harvesting makes the considerable decrement of seed yield in order to decrement of abscission probability and bird damages. Furthermore delay in harvest can be lead to considerable seed loss through unfavorable environmental condition, seed shattering, and embryo damages at harvest (Mendham *et al*., 1990). This report also mentioned that decrement of viability and seed germination can be made by delay harvesting. The main objective of the current research is to determine the most suitable seed moisture content (SMC) at harvest time of two oil-seed rape cultivars (Hyola 401 and Hyola 308) leading to high viability and seed vigour.

MATERIAL AND METHODS

Seed samples for laboratory investigations provided from a trade oil-seed rape production field at Dezful region, Khuzestan province Iran on 2007 and 2008 harvesting time. Around the economical harvest time of two oil-seed rape cultivars (Hyola 401 and Hyola 308) SMC was measured in the field and then enough seed samples were prepared from each cultivar contained 10, 15, 25 and 35 percent of moisture. In order to determine the precise SMC, amounts of each seed samples were oven dried at 153 ± 2 centigrade degrees for 17 ± 1 hour. The other condition was prepared according to standard germination test at 20-30°C on germination paper. The number of germinated seeds was recorded 5 days after planting as primary germination percent (PGP) and also the number of germinated seeds 7 days after planting was noticed as final germination percent (FGP). Furthermore the numbers of normal and abnormal seedlings were recorded (Anonymous., 1999). Mean daily germination (MDG) was calculated according to Hunter *et al*. (1984). Also seedling vigour Index (SVI) was calculated through the equation presented by Abdul *et al*. (1973). Seedling Dry Weight (SDW) can be measured by putting the seedling in oven at 75°C as long as 48 hours. It should be mentioned that the seedling length was measured before weighting the seedlings. Obtained data were analyzed using the MSTATC software with a 2×4 factorial experiment pattern based on completely randomized design (CRD) by assuming of randomizes effect of year. Duncan's multiple range test was applied to compare the means.

RESULTS AND DISCUSSIONS

According to the combined analysis of variance most investigated traits were affected by SMC at harvest time (Table-1). Also oil-seed rape cultivars have significant differences for PGP and FGP. SMC interaction effect with cultivars for all germination indices were statistically significant (Table-1). Mean comparisons of SMC × cultivar × year interaction indicated that the highest PGP and FGP was related to the Hyola 308 cultivar with 35 percent of moisture content (Table-2). Safari *et al,* (2005) stated that the highest PGP was related to the SLMO46 cultivar with 15 percent of moisture content and okapi cultivar had the highest FGP with 15 percent of moisture. In some species with decreasing the SMC after physiological maturity, seed viability would be increased, therefore increasing of PGP and FGP in current research due to decreasing of SMC at harvest time could be expected. The number of normal and abnormal seedling is considered as two criteria for evaluating the germination and seed quality. Whatever the abnormal seedling being a few, the seed germination quality would be increased (Anonymous, 1999). In this study MDG was affected by interaction of cultivar × SMC at

harvest maturity × year (Table-1). Results of mean comparisons showed that the highest amount of MDG (13.7) was earned by Hyola 401 seed which has 15 percent of moisture at harvest time of first year and Hyola 308 cultivar seeds of second year showed the lowest MDG (10.4) at 35 percent of SMC. Hamidi *et al*. (2003) found that the highest rate of MDG was obtained from SLMO46 cultivar with 15 percent of moisture and PF7045191 cultivar produced the lowest rate of MDG.

It has been noticed that seedling length had been affected by no one studied traits. This result confirms the findings of Gurusamy and Thiagarjan (1998). Three way interaction of cultivar × SMC at harvest time × year for seedling fresh weight (SFW) was statistically significant (Table-1). It was noticed that the highest and lowest SFW were related to Hyola 401 cultivar with 15 percent of moisture and Hyola 308 cultivar with 35 percent of moisture, respectively. Seedling dry weight (SDW) is one of the most important criteria for evaluation of seedling vigour. So seedling with more dry weight has more vigour (Hampton and Tekrony, 1995). In our experiment SDW was also affected by SMC at harvest time ($p<0.01$). Mean comparison of three way interaction made clear that highest SDW was gained from Hyola 401 with 15 percent of moisture. Furthermore the lowest SDW was obtained from Hyola 308 with 35 percent of moisture (Table-2). Result showed that seedling vigour index (SVI) was affected by SMC at harvest time in such a manner the highest SVI was related to seeds contained 15 percent of moisture and the other levels of moisture contents (10, 25 and 35 percent) were placed in the other importance degrees. Means comparison of interaction between cultivar × SMC at harvest maturity × year showed that the highest and lowest rate of SVI was produced from Hyola 401 with 15 percent of moisture and Hyola 308 with 35 percent of moisture, respectively.

Daily germination speed (DGS) was affected by SMC at harvest time (Table-1). According to mean comparisons it can be noticed that the highest germination rate was related to seeds which contained 10 and 15 percent of moisture that had been arranged to same statistical groups (Table-2). Also seeds with 25 and 35 percent of moisture were arranged in other importance degrees. Interaction of SMC × cultivar made obvious that the highest and lowest germination speed was obtained from Hyola 401 with 10 and 15 percent of moisture and Hyola 308 with 35 and 25 percent of moisture, respectively. Recently has been stated that seed quality of oil-seed rape would be increased from physiological maturity to harvest maturity (Elias and Copeland, 2001). These findings are contrary to other reports that declare, the highest seed quality occur at physiological maturity. This issue maybe has been arisen in order to physiological changes that had been expressed after physiological maturity and this can increase the germination speed. Furthermore they reported that there was direct correlation between seed quality and seed maturity (Elias and Copeland, 2001).

Regarding to different responses of germination indices of two studied oil-seed rape cultivars to seed moisture content at harvest time, harvesting the oil-seed rape with 15% of SMC could be introduced as the superior treatment. The highest PGP and FGP for both cultivars were earned at 15% of SMC. Also the highest rate of MDG, SFW, SDW and SVI were obtained at this treatment. Meanwhile it was found that the PGP and FGP of Hyola 401 cultivar were more than Hyola 308 cultivar in all treatments and both year.

Table 1. Combined analysis of variance (Mean squares) of oil-seed rape germination indices.

SOV	(Df)	Mean squares(MS)									
		PG[1]	FG[2]	NS[3]	AS[4]	MDG[5]	SL[6]	FSW[7]	DSW[8]	SVI[9]	SDG[10]
Year	1	2.941**	1.432**	3.741	0.046 ns	1.051*	0.0021 ns	0.0021 ns	0.0008 ns	13.741 ns	2.945 ns
Replication * Year	4	4.861*	6.342*	10.781 ns	2.741 ns	0.087*	0.015 ns	0.0071 ns	0.00043 ns	18.963 ns	18.569 ns
Cultivar	1	49.174**	31.746*	4.936 ns	0.741 ns	1.796 ns	4.361 ns	0.00042 ns	0.00039 ns	10.741 ns	24.667 ns
Cultivar * Year	1	24.371**	16.981*	9.741 ns	2.94 ns	1.078 ns	1.756 ns	0.0097*	0.00057*	28.946*	13.748 ns
Seed Moisture Content at Harvest	3	12.468**	14.872**	3.295 ns	3.411 ns	2.948**	0.0067 ns	0.00072**	0.0001**	47.358**	34.961*
Seed Moisture Content at Harvest * Year	3	8.294**	14.852**	15.891 ns	0.051 ns	3.0341*	4.395 ns	0.00014 ns	0.0001 ns	13.759 ns	12.741ns
Seed Moisture Content at Harvest * Cultivar	6	73.281**	69.872**	4.391 ns	3.732 ns	0.007**	2.351 ns	0.00046**	0.00032*	19.937**	17.351**
Seed Moisture Content at Harvest * Cultivar * Year	6	3.645**	3.521**	2.741 ns	4.351 ns	0.047**	1.741 ns	0.0003**	0.0001**	5.489**	12.749 ns
Error	22										

○ NS, not significant, *and ** significant at 5% and 1% respectively.

1- Primary Germination(PG) 2- Final Germination(FG) 3- Normal Seedling(NS) 4- Abnormal Seedling(AS) 5-Mean Daily Germination(MDG) 6- Seedling Length(SL) 7- fresh Seedling weight(FSW) 8- Dry Seedling Weight(DSW) 9- Seedling Vigour Index(SVI) 10-Speed Daily Germination(SDG)

Table 2. Means comparison of oil-seed rape germination indices using Duncan's multiple range tests (DMRT).

Means									
Treatments		PG[1]	FG[2]	MDG[3]	SL[4]	FSW[5]	DSW[6]	SVI 7	SDG[8]
Year	Y_1	91.3a*	93.6a		-	-	-	-	-
	Y_2	88.1b	89.7b		-	-	-	-	-
Year× Replication	$Y_1 R_1$	90.2a	92.3 a	11.1 a	-	-	-	-	-
	$Y_1 R_2$	91.3 a	91.9 a	11.7 a	-	-	-	-	-
	$Y_1 R_3$	86.8b	87.3 b	10.2 b	-	-	-	-	-
	$Y_2 R_1$	92.1 a	92.8 a	11.8 a	-	-	-	-	-
	$Y_2 R_2$	84.4 b	85 b	10 b	-	-	-	-	-
	$Y_2 R_3$	90.9 a	92.1 a	11.9 a	-	-	-	-	-
Cultivar	C_1	91.7 a	93.4 a	-	-	-	-	-	-
	C_2	88.2 b	90.05 b	-	-	-	-	-	-
Year × Cultivar	$Y_1 C_1$	90.2 a	92.5 a	-	-	0.52 a	0.031 a	2.85 a	-
	$Y_1 C_2$	87.3 b	89.1 b	-	-	0.41 b	0.027 b	2.40 b	-
	$Y_2 C_1$	91.6 a	91.8 a	-	-	0.49 a	0.029 a	2.66 a	-
	$Y_2 C_2$	89.1 b	89.5 b	-	-	0.38 b	0.021 b	1.87 c	-
Seed Moisture Content	M_1	89.2 b	92.1 b	11.8 b	-	0.44 b	0.027 b	2.48 b	0.109 a
	M_2	93.7 a	94.5 a	13.1 a	-	0.56 a	0.038 a	3.59 a	0.104 a
	M_3	88.4 b	90.1 b	10.9 c	-	0.42 b	0.025 b	2.25 b	0.087 b
	M_4	85.9c	89.3 c	10.1 c	-	0.37 c	0.019 c	1.70 c	0.075 c
Year × Seed Moisture Content	$Y_1 M_1$	89.5 b	90.2 b	11.3 b	-	-	-	-	-
	$Y_1 M_2$	91.8 a	92.7 a	12.9 a	-	-	-	-	-
	$Y_1 M_3$	86.7 c	89 b	11.9 b	-	-	-	-	-
	$Y_1 M_4$	85.9 c	88.1 b	10.7 c	-	-	-	-	-
	$Y_2 M_1$	89.1 b	89.8 b	11.1 b	-	-	-	-	-
	$Y_2 M_2$	90.7 a	93.1 a	13.0 a	-	-	-	-	-
	$Y_2 M_3$	87.1 b	90.4 b	11.7 b	-	-	-	-	-
	$Y_2 M_4$	88.3 b	89.7 b	10.4 c	-	-	-	-	-
Cultivar × Seed Moisture Content	$C_1 M_1$	91.3 b	93.7 b	12.4 b	-	0.47 b	0.029 b	2.7 b	0.101 a
	$C_1 M_2$	93.2 a	95.4 a	14.6 a	-	0.52 a	0.037 a	3.52 a	0.098 a
	$C_1 M_3$	89.1 b	91.6 b	13.7 b	-	0.43 b	0.026 b	2.65 b	0.076 b
	$C_1 M_4$	86.6 c	89.7	11.9 c	-	0.39 c	0.021 b	1.88 c	0.074 b
	$C_2 M_1$	91.4 b	92.7 b	12.1 b	-	0.41 b	0.031 b	2.87 b	0.102 a
	$C_2 M_2$	92.7 a	94.6 a	13.9 a	-	0.49 a	0.040 a	3.78 a	0.101 a
	$C_2 M_3$	90.1 b	91.3 b	12.5 b	-	0.40 b	0.031 b	2.83 b	0.089 b
	$C_2 M_4$	86.1 c	88.7 c	11.7 c	-	0.37 c	0.028 b	2.48 b	0.084 b
Year×Cultivar× Seed Moisture Content	$Y_1 C_1 M_1$	89.1 b	94.3 b	11.7 b	-	0.35 c	0.022 c	2.07 c	-
	$Y_1 C_1 M_2$	90.7 a	97.1 a	13.7 a	-	0.49 a	0.035 a	3.40 a	-
	$Y_1 C_1 M_3$	87.9 b	92.7 b	12.1 b	-	0.31 d	0.018 d	1.67 d	-
	$Y_1 C_1 M_4$	86.3 b	87.6 c	11.9 b	-	0.30 d	0.019 d	1.66 d	-
	$Y_1 C_2 M_1$	87.2 b	90.2 b	11.2 b	-	0.31 d	0.020 c	1.80 c	-
	$Y_1 C_2 M_2$	89.2 b	92.3 b	12.1 b	-	0.44 b	0.032 b	2.95 b	-
	$Y_1 C_2 M_3$	87.1 b	88.1 c	10.8 c	-	0.32 d	0.021 d	1.85 c	-
	$Y_1 C_2 M_4$	86.1 c	86.9 c	10.2 c	-	0.28 d	0.017 d	1.48 d	-
	$Y_2 C_1 M_1$	89.2 b	93.2 b	11.8 b	-	0.37 c	0.025 c	2.33 c	-
	$Y_2 C_1 M_2$	91.9 a	96.8 a	12.9 a	-	0.47 a	0.035 a	3.39 a	-
	$Y_2 C_1 M_3$	89.4 b	91.9 b	11.5 b	-	0.36 c	0.025 c	2.38 c	-
	$Y_2 C_1 M_4$	87.2 b	89.2 c	11.4 b	-	0.34 c	0.022 c	1.96 c	-
	$Y_2 C_2 M_1$	87.1 b	89.6 c	11.3 b	-	0.34 c	0.023 c	2.06 c	-
	$Y_2 C_2 M_2$	88.7 b	91.7 b	12.2 b	-	0.43 b	0.031 b	2.84 b	-
	$Y_2 C_2 M_3$	86.9 b	89.4 c	10.5 c	-	0.35 c	0.021 c	1.88 c	-
	$Y_2 C_2 M_4$	86.3 c	86.1 c	10.4 c	-	0.29 d	0.015 d	1.29 d	-

* Means, within the same column, followed by the same letters are not different by Duncan's Multiple Range Test ($P<0.05$).

1- Primary Germination (PG) 2- Final Germination(FG) 3-Mean Daily Germination (MDG) 4- Seedling Length (SL) 5-Seedling fresh weight (FSW) 6- Seedling Dry Weight(DSW) 7- Seedling Vigour Index (SVI) 8-Speed Daily Germination(SDG)