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INVESTIGATION OF SEED MOISTURE CONTENT AT HARVEST TIME AS AN EMPIRICAL INDEX FOR IMPROVING VIABILITY AND SEED VIGOUR OF TWO OIL-SEED RAPE CULTIVARS

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ABSTRACT

In order to evaluate the role of seed moisture content (SMC) at harvest time of two oil-seed rape cultivars (Hyola 401 and Hyola 308) in seed viability and vigour, a laboratory investigation was conducted at Seed and Plant Certification and Registration Institute (SPCRI) in Karaj, Iran. Seed samples provided from 2007 and 2008 growing season of a trade oil-seed rape field which is located at Dezful region, Khuzestan province, Iran. Enough seed samples were prepared from each cultivar contained 10, 15, 25 and 35 percent of moisture at harvest time and studied for several germination indices. Experimental data were arranged in a 2×4 factorial experiment based on completely randomized design with three replications. Results showed that the highest primary and final germination percent for both cultivars were earned at 15% of SMC. Also the highest rate of mean daily germination, seedling fresh weight, seedling dry weight and seedling vigour index were obtained at 15% of seed moisture content. Meanwhile it was found that Hyola 401 cultivar was superior to Hyola 308 in all treatments and both year for primary and final germination percent. Altogether Since the seed quality has been affected by experimental condition, harvesting two investigated cultivars of oil-seed rape with 15% of SMC is recommended.

Keywords: oilseed rape cultivars, seedling vigour, seed moisture content, viability, harvest maturity, germination.

INTRODUCTION

Seed as main tool for plant propagation and the most important issue for plant production has been severely considered by agronomists and many researchers who studied seed physiology and crop breeding. Seed is considered as approaching factor of yield potential in respect of quantitative and qualitative production (Agrawal, 1980). The necessity of seeds for crop production and their importance in the aspect of quality and their relation to plant production, seed multiplying, seed control and certification programs have had significant importance about preservation of genetic ancestry and providing the reliable sources of the seeds for farmers.

According to several researches, stage of seed development at harvest time influences both oil-seed rape (*Brassica napus* L.) yield and seed quality. Harvesting too early may result in low yield and seed quality, decrement of viability and seed germination (Mcdonald *et al*., 1997; oplinger *et al*., 1989) 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. If oil-seed rape is harvested after the appropriate time, crop loss can be expected as a result of over ripening which cause pods to shatter easily, especially under adverse weather conditions (oplinger *et al*., 1989). Delouchi (1980) defined harvest maturity as when seed moisture content (SMC) is low enough to allow effective threshing with a mechanical harvester. Oil-seed rape has relatively long flowering period and seed maturity occurred in different times. Therefore seeds from the earlier flowers are suitable for harvesting; however another seeds in the latest flowers are at grain filling stage. The SMC at maturity stage will be decreased by the time and subsequently seed maturity occurs in different times and because of this issue, determination of accurate harvesting time is considered important. Also it should be mentioned that seed maturity has the significant effect on seed quality, processing, storability, viability and seedling vigour (Gurusamy and Thiagarajan., 1998).

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*., 1981). Mendham *et al*., (1990) indicated that early harvest of oil-seed rape caused seed deformation and yield loss because of being high SMC, while Ward *et al*., (1992) revealed that early harvest may increases the chlorophyll and decreases the seed yield, oil quality, seed viability and germination.

In general until seeds have not completed the minimum morphogenesis stage in the respect of embryogenesis development, the germination can not occur at favorable condition (Mendham *et al*., 1981). In the most crop species seeds are able to germinate before maturity and physiological harvest stage. Some seeds are able to gain the capability of germination only a few days before anthesis and more time before harvest (Bewely and Black., 1983). It has been understood that larger seed size would let to increasing the capability of viability and seed germination by the time. So in some species by decrement of SMC after physiological maturity or harvest maturity, seed viability would be increased (Bewely and Black., 1983; Elias *et al*., 1992; Galanopolu *et al.*). Furthermore, increment of primary and final germination percent (PGP, FGP) with decrement of SMC at harvest time has been arisen from the above mentioned issue. It has reported that decreasing effect of delayed harvesting in soybean seed viability is more than delayed sowing (Mugnisjah and Nakamura., 1984; Tekrony *et al*., 1980). 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. The experimental field was located at 32° 16' N, 48° 25' E and 82 masl). 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. Finally the samples were transported to the laboratory in Seed and Plant Certification and Registration Institute (SPCRI) in Karaj . 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., 1993; 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 m 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. Hamidi *et al.* (2003) reported that SLMO46 cultivar with 15 percent of moisture have had the highest PGP and FGP. Germination can occur only when the seeds have completed the morphogenesis stages from the aspect of embryogenesis development (Bowles, 1992). Although seeds from the most species are able to germinate before maturity and physiological harvest stage, some seeds are able to gain germination power only a few days before anthesis and much time before the common harvest time (Bewely and Black., 1983). By increment of seed size and seed maturity development, the viability and germination will be increased by the time. Since 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, 1993). The results of ANOVA showed the numbers of normal and abnormal seedling were not affected by the studied traits (Table-1, 2). The results of the correlation coefficient revealed that there were significant positive correlation between normal seedling and PGP and FGP (Table-3). Safari *et al* (2005) reported that Okapi cultivar which contained 15 percent of seed moisture has the highest amount of normal seedling. Also regarding to Agrawal (1980) SLMO46 cultivar which contained 10 percent of moisture produced the lowest rate of normal seedling.

Man daily germination (MDG) is considered as criterion for seed germination and seed viability (Bewely and Black., 1983). 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 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. The results of simple correlation coefficient recognized that there has been highly significant and positive correlation between MDG with PGP and FGP (Table-3). So it has been observed that earlier and delay harvest by decreasing of seed maturity can decrease the MDG.

Safari *et al* (2005) reported that the highest rate of MDG was related to the seeds contained 15 percent of moisture at harvest time but they did not noticed significant difference between studied cultivars for MDG.

Also 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. Seedling length is a trait that is considered as seedling vigour. It was clear that there had been a significant correlation between seed length and seedling vigour in many species (Hampton and Tekrony, 1995). We didn't find any significant difference for seedling lengths between experimental treatments. This result confirms the findings of Gurusamy and Thiagarjan (1998). They have reported that seedling length was not affected by delay harvesting. 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. Results made obvious that there was significant and positive correlation between SFW to PGP and FGP (Table-3).

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. Results of correlation coefficient made clear that there had been significant and positive correlation among SVI and PGP and FGP, normal seedling number, MDG, SFW and SDW (Table-3).

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).

CONCLUSIONS

Based on this study it can be recognized that the seed quality and its different aspects has been affected by experimental conditions. 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.

S.O.V.	(df)	Mean squares (MS)									
		PG[1]	FG[2]	NS[3]	AS[4]	MDG[5]	SL[6]	SFW[7]	SDW[8]	SVI[9]	DGS[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*	10.781ns	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
SMC	3	12.468**	14.872**	3.295 ns	3.411 ns	2.948**	0.0067 ns	0.00072**	0.0001**	47.358**	34.961*
SMC × 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
SMC × 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**
SMC × 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										

Ad ×anns, non significant, *and ** significant at 5% and 1% probability level 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- Seedling fresh weight (SFW); 8- Seedling dry weight (SDW); 9- Seedling Vigour Index (SVI); 10- Daily Germination Speed (DGS).

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

Treatments		Means									
		PG[1] (%)	FG[2] (%)	NS[3]	AS[4]	MDG[5]	SL[6] (mm)	SFW[7] (g)	SDW[8] (g)	SVI[9]	DGS[10]
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

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	M_4	85.9c	89.3 c	-	-	10.1 c	-	0.37 c	0.019 c	1.70 c	0.075 c
Year × SMC	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 × SMC	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× SMC	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 have not significant difference by Duncan's Multiple range test ($P<0.05$).

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-Seedling fresh weight (SFW); 8- Seedling dry weight (SDW); 9- Seedling vigour index (SVI); 10- Daily germination speed (DGS).

Table 3. Simple correlation coefficients among oil-seed rape germination indices.

No. of criteria	PG[1]	FG[2]	NS[3]	AS[4]	MDG[5]	SL[6]	SFW[7]	SDW[8]	SVI[9]	DGS[10]
(1)	1									
(2)	0.874**	1								
(3)	0.741**	0.971**	1							
(4)	-0.767	-0.732*	-0.598**	1						
(5)	0.735**	0.863**	0.261*	-0.326*	1					
(6)	0.534*	0.687 ns	-0.308 ns	-0.271 ns	-0.436 ns	1				
(7)	0.649*	0.727**	0.531 ns	0.437 ns	0.639*	0.567*	1			
(8)	0.438*	0.652**	0.341 ns	0.329 ns	0.584v	0.498*	0.832**	1		
(9)	0.493*	0.694**	0.369*	-0.541**	0.472**	0.361 ns	0.497v	0.373*	1	
(10)	-0.581*	0.460*	0.438 ns	0.507 ns	-0.609*	0.273 ns	0.683*	0.497*	-0.420*	1

ns = non significant, *and ** significant at 5% and 1% probability level, 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-Seedling fresh weight (SFW); 8- Seedling dry weight (SDW); 9- Seedling vigour index (SVI); 10- daily germination speed (DGS).

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