International Journal of Agronomy and Agricultural Research (IJAAR)
ISSN: 2223-7054 (Print) 2225-3610 (Online)
http://www.innspub.net
Vol. 4, No. 6, p. 27-33, 2014

RESEARCH PAPER | OPEN ACCESS

Application of biophysical and biochemical methods as priming techniques on *Carthamus Tinctorius L.*

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Article published on June 16, 2014

Key words: priming techniques, chemical method, physical method, safflower.

Abstract

For disclosing the effects of seed priming with biophysical and biochemical methods on yield and other characteristics on safflower (*Carthamus Tinctorius L.*), the seeds of one safflower cultivar was treated with 72 mT strength for 10 min, hydro priming for 72 hours and gibberellic acid with 50ppm concentration for 8hours before germination and cultivation. In this experiment traits such as yield components, seed yield, biological yield, harvest index, petal yield, percentage of oil, percentage of huld seed and correlations were measured. Seed priming was significantly impressed characteristics under study. Plants showed that yield parameters and major traits were increased, in most cases, for magnetic treatment versus control (non-treated seeds) and other pre-treatments. Results indicated that biophysical methods (magnetic field) had greatest difference with biochemical methods and control at traits under study.

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Introduction

Seed priming is the most important physiological seed enhancement method. Seed priming is a technique of controlled hydration (soaking in water) and drying that result in more rapid germination when the seeds are re-imbibed. In recent decades, physical techniques based on the application of magnetic field (MAG) are being developed in the agricultural sector, and many bio-electromagnetism research reports focusing on the investigation of magneto sensitivity of living organisms has increased. Plants mean an attractive model for the study of biological effects of magnetic fields (Florez *et al*., 2012). Stimulation of plants through magnetic field can improve quality and quantity of crops and many studies from all over the world have provided evidence proving its influence (Vasilevski, 2003). Various researchers have studied and reported that magnetically treated maize, wheat, sunflower, barley, corn, beans, tomato, fruits and mushrooms etc. showed high performance in terms of germination, seedling establishment, plant growth, height, yield, mass per spike as well as shoot and root length and assimilation of fresh and dry matter (Jamil *et al*., 2012). Iimoto *et al.* (1996) found that applying a magnetic field of 4 mT provided inside the bottle conditions can create useful effects for CO_2 absorption in potato offshoots. It has been found that magnetic fields have varied influences and this variation depends on severity, frequency, duration of treating operation, genotype and biological system (Blank and Goodman, 1996; Goodman *et al*., 1995). Seeds treatment by magnet S pole increases growing and budding rate and create large leaves. The earth magnetic field has a direct effect on growing rate on some plants. Provided evidences by experiments show that wheat growing rate increase by about 5 times under such conditions (Gusta *et al*., 1994). Hoseini *et al.* (2013a) found that magnetic field with power 75 mT can increase essential oil concentration in lemon balm for 2.2 times. Florez *et al.* (2005) observed increase in the rate of elongation of wheat seedlings under magnetic conditions; also Florez *et al.* (2012) exposed *Salvia Officinalis L.* and *Calendula Officinalis L.* seeds to 125 mT stationary magnetic fields generated by magnets at different times. Results indicated that magnetic field application enhanced germination rate and percentage of germinated seed on the treated group compared to the non-exposed in both cases. One of the biochemical methods is the treatment by growing adjusters which is utilized in this experiment. Koranteng and Matthews (1982) found that applying 20 g/ml of Gibberellic acid during the initial stage of growing in barley can lead to a significant increase in stalk forming, the number of spike, and seed yield. Ma and Smith (1992) observed the similar results from applying Cycocel and Ethephon in growing stage of barley. Hoseini *et al.* (2013b) found that seed treatment by GA_3 with content of 50 ppm carried out prior to planting, can improve root length, budding proportion, vigor of plant, particularly for fennel seeds of low quality. Another utilized method is hydro-priming treatment. Demir-Kaya *et al.* (2006) considered hydro-priming effects on sunflower seeds, the results indicated that it accelerates the germination process in dry conditions and shortens the germination period. Tajbakhsh *et al.* (2004) investigated different treating methods on onion and the obtained results indicated that hydro-priming in high humidity leads to shortening the average germination time. Kaur *et al.* (2002) found that priming of pea by water and mannitol (4%) for 12 hours in 25centigrade can increase the number and biomass of plants knots. Hydro-priming improves the power of germination in plants of sesame species and speeds the germination and solid weight of the plant in lab conditions (Eskandari, 2011). Hydro-priming of bean seeds in water for 7-14 hours can improve the plant performance (Ghassemi-Golezani *et al.,* 2010). But effect of implicit treatments is different in variety plants, Kordas (2002) stress that magnetic field had the no significant effect on yield of spring wheat. But had the negative effects on stem and ear length and root volume. Also, the application of 25 or 50 g/ha of GA_3 reduced the average of seed yield but the 5 g/ha GA_3 had no effect on yield (Leite *et al.,* 2003). The main objective of this study was to evaluate the efficiency of biophysical and biochemical methods on yield and other traits of safflower (*Carthamus tinctorius L.*).

Materials and methods

Seeds and treatments

The treatments were conducted at research laboratory on safflower. Germination test according to the guidelines issued by the international seed testing association, with slight modification was carried out under laboratory condition to obtain the seed viability. Seeds had high viability (98%). Seeds were primed with various materials, including hydro-priming (HP) which seeds were placed in an aquarium for 72hours in conditions that relative humidity and temperature were 100 and 20% respectively, treatment by GA_3 solution with concentration 50ppm for 8hours, magnetic field (MAG) treatment in which seeds before exposing to magnetic field are sowed for 5hours and subsequent surface-dried with paper towels and allowed to air dry for 20 min (MAG-20) under room temperature. Finally, seeds were subjected to magnetic field treatment for 10 min (MAG-10), with 72 mT strong. Non-primed seeds were included in the experiment for comparison. Immediately in first time primed seeds were cultivated. The land was plowed before planting. Fertilizers were applied according to the soil test recommendation.

Experimental design and cultural details

The calculated characteristics were: yield components, seed yield, biological yield, harvest index, petal yield, oil percentage, percentage of huld seed, and correlations. Experimental design was a randomized complete block with 5 replications. At maturity safflower plants were harvested by hand, traits were determined. The data obtained from experiment statistically were analyzed and least significant difference (LSD) values were used to identify the means that differed significantly.

Results and discussion

The effect of seed treatment on components of yield

Analysis of the yield components data revealed that different priming techniques had significant effect on the traits under study (Table 1). The greatest difference between treated seeds and control were obtained when seeds were treated by magnetic field. The number of head per plant was increased 109% as compared with control. The comparison of treatment means indicated that GA_3 and hydro-priming had statistically similar the number of head per plant. GA_3 and hydro-priming increased 43% the number of head per plant. Mohammadi (2009) reported that seed priming with potassium nitrate increased the number of pods per plant, the number of seeds per pod, 1000-seed weight and yield 56.5, 23.8, 6.2 and 44.3% respectively as compared to control (Fig1). Among the priming treatments, the highest values of 1000-seed weight occurred when the seeds primed with magnetic field. There were no significant differences between GA_3 treatment and hydro-priming treatment with control for 1000-seed weight. Moreover, there was no significant difference between magnetic field treatments, GA_3 and hydro-priming treatments for the number seed per head. Overall, seed priming treatments let to improve the number seed per heed.

The effect of seed treatment on safflower yield

Seed yield: Statistically significant differences, with regarded to seed yield, was observed among the seed treatments and the non-treated seeds resulted in the lowest yield. Comparison of treatment means (Table 2) indicated that seed yield from magnetic field treatment was higher than those from GA_3, hydro-priming treatments. The lowest enhancement in seed yield was obtained under hydro-priming treatment. Statistically minimum yield was observed in non-treated seeds.

Petal yield: As well as petals of safflower as commercial production are valuable. This trait was improved when priming was applied to seed treatment. The best results were obtained for magnetic field and hydro-priming, respectively. The effect of priming by GA_3 on this trait was no significant.

Table 1. Analysis of variance seed priming treatments on traits of safflower.

S.O.V	DF	head	Seed /head	1000 seed weight	Seed yield (kg/ha)	Petal yield (kg/ha)	Biologic yield (kg/ha)	Harvest index	Oil (%)	Oil yield	Huld seed(%)	Kernel /seed
Block	4	2.163	13.878	18.223	179891.88	0.222	2500034.182	21.973	8.422	10559.629	.751	35.462
Treatment	3	39.842^{**}	313.593^{**}	202.586^{**}	6199458.317^{**}	21.959^{**}	167509056.246^{**}	66.65^{**}	133.918^{**}	785060.904^{**}	111.541^{**}	115.616^{ns}
Error	12	1.507	16.695	24.012	116319.026	0.096	2531781.221	13.759	6.935	12855.796	0.431	53.334

Biological yield: According to the results obtained from the analysis of variance (Table1) and comparison of treatment means (Table2) priming had the significant effects on biological yield. The plants produced from the seeds primed with magnetic field showed the highest values of the trait under study. Regardless of not significant between GA_3, hydro-priming treatments, biological yield from pretreated seeds with these were higher than those from non-treated seeds. Although significant effect of different priming techniques on seed yield and biological yield, harvest index from different treatments was no significant. Farooq *et al.* (2007) found that seed treatment by hydro-priming and osmo-priming (kcl, $cacl_2$, ascorbic) improve yield. Inhancment yield as increasing fetile claw. The best result was obtained for $cacl_2$ treatment. Rashid *et al.* (2004) reported that priming in bean let to increase yield and biomass.

Table 2. Mean comparision of the traits under different treatments.

Treatment	head	Seed /head	1000 seed weight	Seed yield (kg/ha)	Petal yield (kg/ha)	Biologic yield (kg/ha)	Harvest index	Oil (%)	Oil yield	Huld seed (%)
MAG	13.19 a	42.4 a	59.93 a	4007 a	4.762 a	25160 a	15.98 ab	31.55 a	1264 a	1.38 c
HP	9.134 b	35.08 b	50.7 b	2479 c	2.196 b	15650 b	15.94 ab	22.05 c	546.4 b	2.62 b
GA3	9.11 b	36.89 ab	46.72 b	3028 b	0.386 c	15330 b	20.53 a	19.66 c	653.9 b	3.07 b
Control	6.34 b	23.56 c	46.17 b	1338 d	0.286 c	11580 c	11.63 b	25.68 b	343.7 c	22.7 a

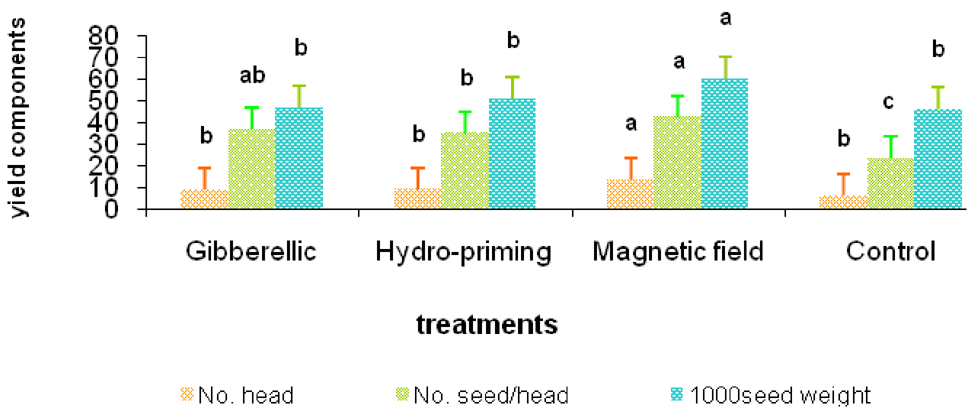

Fig. 1. Effect of priming treatments on yield components

The effect of seed treatment on percentage of oil

Results showed that magnetic field application enhanced percentage of oil compared to control. This trait was reduced compared to control when seed primed with GA_3 and hydro-priming. But as for seed yield produced by GA_3 and hydro-priming, oil yield obtained from GA_3 and hydro-priming was higher than control (Table2). Potter *et al.* (1993) detected an increase in percentage of oil of napse (*Brassica napus L.*) with application GA_3.

The effect of seed treatment on percentage of huld seed

According to the calculations obtained from percentage of huld seed priming had the significant effects on this trait (Table1). The maximum percentage of huld seed was observed to control. The percentage of huld seed was reduced by 1.38% compared to control when seed primed with magnetic field. Also, other treatments resulted in lowering the percentage huld seed. There was no significant difference between treated seeds and non-treated seed for kernel/seed (Table1).

Correlations of traits

All of the traits under study showed the significant and positive correlations (at the 1% level of probability) with yield. Except percentage of oil and huld seed that had no significant and negative correlations respectively. Among the yield components, the number of head per plant showed the highest correlation with yield indicating the notable effect of this component on safflower yield (Table3). The correlation of other traits was showed in table 3 The results of Mokhtassi *et al.* (2006) showed that among the yield components and yield exist high positive correlations.

Table 3. Simple correlations of between traits under study.

Trait	head	seed/head	1000 seed weight	Seed yield (kg/ha)	Petal yield (kg/ha)	Biologic yield (kg/ha)	Harvest index	Oil (%)
Seed/head	0.666**							
1000 seed weight	0.62**	0.499*						
Seed yield(kg/ha)	0.848**	0.786**	0.513*					
Petal yield(kg/ha)	0.831**	0.631**	0.821**	0.725**				
Biologic yield(kg/ha)	0.792**	0.755**	0.802**	0.787**	-----			
Harvest index	0.421ns	0.33ns	-0.245ns	0.610**	-----	0.000		
Oil(%)	0.44ns	0.131ns	0.655**	0.31ns	0.7**	-----	-----	
Huld seed(%)	-0.743**	-0.869**	-0.448**	-0.829**	-0.617**	-----	0.949**	-0.016ns

Conclusion

As for results obtained in experiment, it sounds that biophysical methods (magnetic field) are more efficiency than biochemical methods(GA_3 and hydro-priming). In summary, stationary magnetic field and other treatments could be used as the physical and chemical techniques to improve the yield components and yield.

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