

# Influence of Seed Priming Techniques on the Seedling Establishment, Yield and Quality of Hybrid Sunflower

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## ABSTRACT

A field study was conducted to evaluate the influence of seed priming techniques on the seedling establishment, yield and quality of hybrid sunflower. Seeds were hydro primed for 24 h, hardened for 24 h, matriprimed for 24 and 48 h, osmoprimed with 0.5% KNO<sub>3</sub> for 12 h and with 0.1% NaCl for 12 h. Seed priming techniques affected seedling establishment, yield and quality of hybrid sunflower significantly. Hydropriming and osmopriming with NaCl resulted in lower time taken to 50% emergence and mean emergence time and higher final emergence, energy of emergence, plant population, achene yield and yield contributing factors and achene proteins but time to start emergence, plant height and achene oil contents were not affected significantly by different seed priming. Hardening resulted in similar to or even inferior performance than that of untreated seeds.

**Key Words:** Priming; Sunflower; Quality; Yield

## INTRODUCTION

Pakistan has chronic deficiency in edible oil, being the third biggest importer of edible oil in the world. Edible oil is Pakistan's largest single food import with consumer's demand steadily increasing from 0.3 million tones to 2.0 million tones during the last two decades with stagnant domestic production of about 0.56 million tones (Government of Pakistan, 2004). The need to import vegetable oil in increasing amount is imposing a severe threat to economy. Now it is the need of the time to reduce our import of edible oil by increasing our domestic production. Edible oil in the country either comes from conventional (rapeseed, mustard, groundnut, sesame, linseed & cotton etc.) or non-conventional (soybean, safflower & sunflower) crops. Rapeseed and mustard are the major winter oilseed crops and contribute about 10 - 13% to the domestic edible oil production (Government of Pakistan, 2004). But unfortunately, rapeseed and mustard oil is not regular cooking oil due to the presence of higher concentration of erucic acid and glucosionlates and therefore, cannot be used more than 5% in oil blending for ghee manufacturing (Government of Pakistan, 2004). Obviously the edible oilseed production can be increased by two means, either by horizontal or vertical expansion. In the present situation, the horizontal expansion in oil seed crops is impossible, so vertical expansion is the option. Consequently we must search for non-conventional oilseed crops. For this, the most promising crops are sunflower and soybean. Sunflower is high yielding, non-conventional oilseed crop and has the potential to bridge up the gap. Furthermore, sunflower is a short duration crop (90 - 110 days) and can be grown twice in a year. It is fully fit in our

cropping system and can be grown without causing displacement of any major crop. At present sunflower is grown on an area of 65 thousand hectares with total production of 76 thousand tones and an average yield of 1774 kg ha<sup>-1</sup> (Government of Pakistan, 2004).

Under prevailing conditions, per hectare yield of this crop is very lower than that of potential of different varieties under cultivation. Among the factors responsible for low yield are high weed infestations, imbalance use of fertilizers, improper plant protection cover and sub optimum plant population. Sub optimum plant population generally results from poor and erratic germination.

In recent years, a lot of work has been done on the invigoration of seeds to improve the germination rate and uniformity of growth and reduce the emergence time of many vegetables and some field crops (Basra *et al.*, 2003).

Furthermore, the invigoration persists under less than optimum conditions such as salinity (Muhyaddin & Weibe, 1989), excessively high and low temperature (Pill & Finch-savage, 1988; Bradford *et al.*, 1990). Seed invigoration treatments such as hydropriming, osmopriming, hardening, matripriming and growth regulators have been successfully employed in many parts of the world.

Although, earlier, Chojnowski *et al.* (1997) and Shahbaz *et al.* (1998) has done precious work on sunflower seed invigoration, still very limited informations are available regarding the performance of hardened, osmoprimed, matriprimed and hydroprimed seeds hybrid sunflower.

The present study was, therefore, carried out with the objective to evaluate the effects of seed priming treatments on the seedling establishment, quality and yield of hybrid sunflower to find out the most promising technique.

## MATERIALS AND METHODS

**Experimental site.** The study was conducted at Agronomic research farm, University of Agriculture, Faisalabad, Pakistan during autumn, 2003 - 04. The experiment was laid out in the randomized complete block design (RCBD) with three replications.

**Seed materials.** Sunflower hybrid Hysun-33 was used in the present study. The seeds were obtained from National Oilseeds Programme, National Agricultural Research Center, Islamabad, Pakistan. The initial seed moisture contents were 8.13% (on dry weight basis).

### Seed Treatments

**Hydropriming.** Sunflower seeds (250 g) were soaked in aerated distilled water for 24 h (Basra *et al.*, 2002).

**Hardening.** A weighed quantity of seeds (250 g) were soaked in tap water at 27°C for 24 h followed by redrying to initial moisture under shade with forced air at 27 ± 3°C. The cycle was repeated twice (Basra *et al.*, 2003).

**Matrimpriming.** Sunflower seeds were soaked between the two layers of saturated gunny bags at 27°C for 24 h and 48 h. (Basra *et al.*, 2002).

**Osmoprimering.** The seeds were soaked in aerated solutions of 0.5% KNO<sub>3</sub> and 0.1% NaCl for 12 h. The ratio of seed weight to solution volume was 1:5 (g/ mL) (Basra *et al.*, 2004).

**Post treatment operations.** After treatment, seeds were given three surface washings with distilled water and redried to original weight with forced air under shade at 27 ± 3°C (Basra *et al.*, 2002). These seeds were then sealed in polythene bags and stored in refrigerator at 5°C before further use.

**Land preparation.** Four cultivations followed by two plankings were given to achieve the desirable soil structure.

**Crop husbandry.** Treated and untreated seeds were sown on the 15<sup>th</sup> of August with the help of dibbler at a seed rate of 8 kg ha<sup>-1</sup> in the pattern of row-to-row distance of 60 cm and plant-to-plant distance of 30 cm. Nitrogen and phosphorus were applied @ 100 and 75 kg ha<sup>-1</sup>, respectively. Half of the nitrogen and whole of the phosphorus were applied at sowing time and remaining nitrogen was applied with first irrigation. One hoeing was done to keep the crop weed free.

**Observations.** The time to get 50% emergence (E<sub>50</sub>) was calculated according to the following formulae of Coolbear *et al.* (1984) modified by Farooq *et al.* (2005):

$$E_{50} = t_i + \frac{\left(\frac{N}{2} - n_i\right)(t_j - t_i)}{n_j - n_i}$$

Where N is the final number of emergence and n<sub>i</sub>, n<sub>j</sub> cumulative number of seeds germinated by adjacent counts at times t<sub>i</sub> and t<sub>j</sub> when n<sub>i</sub> < N/2 < n<sub>j</sub>.

Mean emergence time (MET) was calculated according to the equation of Ellis and Roberts (1981):

$$MET = \frac{\sum Dn}{\sum n}$$

Where n is the number of seeds, which were germinated on day D, and D is the number of days counted from the beginning of emergence.

Energy of emergence was recorded on the 4<sup>th</sup> day after planting. It is the percentage of germinating seeds 4 days after planting relative to the total number of seeds tested (Ruan *et al.*, 2002).

The mature crop was harvested manually on 7<sup>th</sup> December and the observations regarding yield and yield contributing factors were recorded.

**Achene oil content.** Achene oil contents were determined by following soxhlet fat extraction method (AOAC, 1984).

**Achene protein.** Achene nitrogen was determined by kjeldhal apparatus and multiplied by correction factor (6.25) to get Achene proteins (Jackson, 1962).

## RESULTS

The effect of seed priming techniques on the time to start emergence was non-significant. All the seeds germinated three days after sowing (Table I).

Statistically maximum E<sub>50</sub> was noted in hardened seed (3.73 d), which was statistically similar to that of control (3.72 d). All other treatments resulted in lower E<sub>50</sub> compared with control. Minimum E<sub>50</sub> was calculated from seeds subjected to osmoprimering with 0.1% NaCl (3.55 d), which was statistically similar to that of hydroprimed seeds (3.56 d). Maximum MGT was resulted from osmoprimering with 0.5% KNO<sub>3</sub> (6.11 d), which was statistically similar to that of control (6.07 d) and the hardened seeds (5.98 d). All other treatments resulted in lower E<sub>50</sub> compared with control. Minimum MGT was noted in matrimprimed seeds (5.67 d), which was statistically at par with seeds osmoprimered with 0.1% NaCl (5.79 d) and hydroprimed (5.79 d). Maximum GE and FGP were recorded in hydroprimed seeds, which were statistically similar to that of seeds subjected to osmoprimering with 0.1% NaCl, followed by matrimpriming for 24 h, which was statistically similar with that of control (Table I). All other treatments resulted in lower GE and FGP compared with control (Table I). The effect of seed priming techniques on the plant height was non-significant (Table I).

Maximum plant population was recorded in hydroprimed seeds (4.60), which was statistically similar to that of seeds osmoprimered with NaCl (4.57), followed by control (4.17), which was statistically similar to the seeds matrimprimed for 24 and 48 h (4.17). Other treatments resulted in lower plant population compared with that of control (Table II). Statistically maximum head diameter was measured in osmoprimering with KNO<sub>3</sub>, which was similar to

**Table I. Influence of seed priming on the seedling establishment of hybrid sunflower**

Treatments	Time to start emergence	E <sub>50</sub> (days)	MET (days)	EE (%)	FEP (%)	Plant height (cm)
Control	3	3.72 ab	6.08 a	83.41 b	83.70 b	164.49
Hydropriming	3	3.56 d	5.79 cd	87.79 a	88.20 a	172.05
Seed hardening	3	3.74a	5.983ab	76.66 d	76.67 d	160.72
Matrimpriming for 24 h	3	3.68 bc	5.890bc	83.53 b	83.33 b	164.43
Matrimpriming for 48 h	3	3.67 bc	5.67 d	79.53 c	80.50 c	166.16
Osmoprining (KNO <sub>3</sub> )	3	3.66 c	6.11 a	76.46 d	80.00 c	168.44
Osmoprining (NaCl)	3	3.55 d	5.79 cd	87.46 a	87.60 a	164.11
LSD at 0.05	n.s.	0.056	0.1258	2.06	2.62	n.s.

Means not sharing the same letters in a column differ significantly at p 0.05, E<sub>50</sub>= Days to get 50% emergence; MET = Mean emergence time, EE = Energy of emergence, FEP = Final emergence percentage

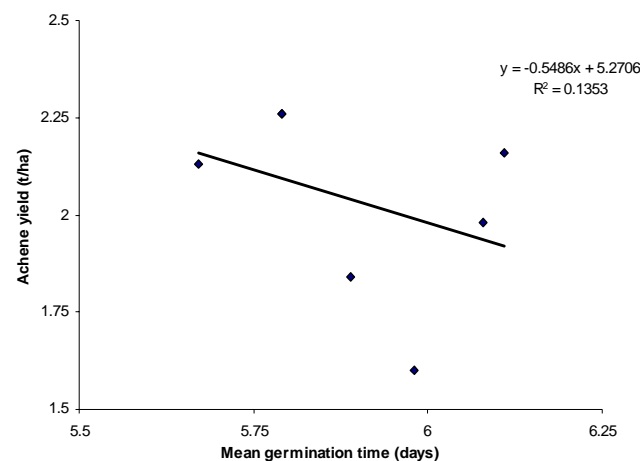
**Table II. Influence of seed priming on the yield and quality of hybrid sunflower**

Treatments	Plant population (m <sup>-2</sup> )	Head diameter (cm)	No. achenes head <sup>-1</sup>	of 1000-achene weight (g)	Achene yield (t ha <sup>-1</sup> )	Biological yield (t ha <sup>-1</sup> )	Harvest index (%)	Achene oil content (%)	Achene protein contents (%)
Control	4.17 b	15.60 c	815.7 c	51.08 b	1.980 c	6.75 c	28.32 b	37.81	27.49 b
Hydropriming	4.60 a	16.67 b	900.3 a	55.76 a	2.263 a	7.30 a	31.60 a	36.47	29.73 a
Seed hardening	3.93 c	16.61 b	757.7 d	51.23 b	1.600 e	6.05 d	26.40 d	36.55	30.38 a
Matrimpriming for 24 h	4.17 b	15.88 c	766.3 d	52.32 b	1.840 d	6.83 bc	26.80 cd	37.43	27.78 c
Matrimpriming for 48 h	4.17 b	16.79 ab	858.7 b	57.21 a	2.127 b	6.99 b	27.75 bc	36.86	28.37 b
Osmoprining (KNO <sub>3</sub> )	4.00 c	17.19 a	898.3 a	55.93 a	2.160 b	7.02 b	28.08 bc	37.88	29.77 a
Osmoprining (NaCl)	4.57 a	16.94 ab	900.3 a	55.23 a	2.260 a	7.25 a	31.23 a	36.14	30.30 a
LSD at 0.05	0.113	0.409	38.12	2.706	0.079	0.218	1.27	n.s.	1.197

that of osmoprining with NaCl and matrimpriming for 48 h; minimum head diameter was measured in matrimprimed for 24, which was similar to that of control. Maximum number of achenes per head, 1000-achene weight, biological and achene yield; harvest index and achene proteins were recorded in hydroprimed seeds, which was similar to that of osmoprining with NaCl (Table II). However, minimum number of achenes per head, biological and achene yield and harvest index was recorded in hardened seeds (Table II). Minimum achene proteins were observed in matrimpriming for 24 h, followed by matrimpriming for 48 h, which was similar to that of un-treated control (Table II). There was negative correlation between mean emergence time and number of achene yield (Fig. 1) Positive correlation was noted between head diameter and number of achenes per head (Fig. 2) and 1000-achene weight and achene proteins (Fig. 3).

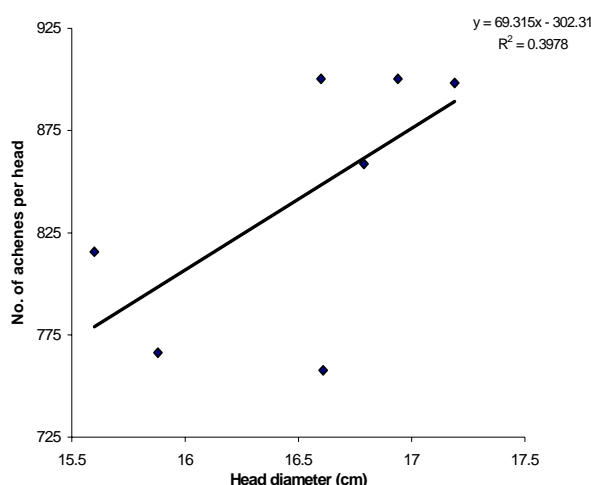
## DISCUSSION

It is revealed from the present study that different priming techniques can enhance the seedling establishment and, yield and quality of sunflower. Primed seeds had higher vigor levels (Basra *et al.*, 2002), which resulted in earlier start of emergence (Basra *et al.*, 2002). Positive correlation between seed vigor and field performance had also been found in rice (Yamauchi & Winn, 1996). Seed hardening behaved similar to or even inferior to that of control, which might be the result of membrane rupture, which might have resulted in loss in seedling vigor. Seed priming techniques resulted in enhanced seedling vigor as

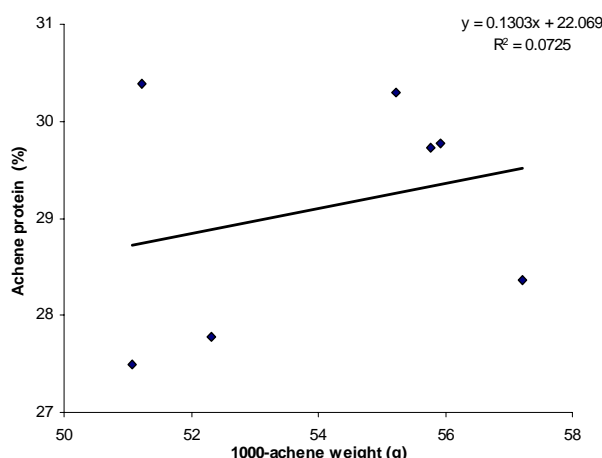
**Fig. 1. Relationship between mean germination time and achene yield in hybrid sunflower as affected by seed priming treatments**

well, as indicated by high energy of emergence and emergence percentage. Seed priming may help in dormancy breakdown possibly by embryo development and/ or leaching of emergence inhibitors (Yamauchi & Winn, 1996), which resulted in increased GE and FEP. These results are in confirmation with that of Haigh and Barlow (1987), who found that KNO<sub>3</sub> was beneficial in decreasing the emergence spread for seeds of several species. Gray *et al.* (1984) concluded that osmoprining of a slowly germinating stock improved the percentage seedling

**Fig. 2. Relationship between head diameter and no. of achenes per head in hybrid sunflower as affected by seed priming treatments**



**Fig. 3. Relationship between 1000- achenes weight and achene proteins in hybrid sunflower as affected by seed priming treatments**



emergence compared with un-treated seeds. Priming also reduced the mean emergence time but had no effect on the spread of emergence time of parsnip seeds. Nerson and Govers (1986) subjected the seeds of muskmelon to salt priming and found that 2 - 3% solutions of  $\text{KH}_2\text{PO}_4 + \text{KNO}_3$  (1:1) for 1 - 5 days significantly increased the emergence rate, synchronization and percentage. Kathiresan *et al.* (1984) reported enhanced field emergence from ascorbic acid NaCl and  $\text{CaCl}_2$  treated sunflower seeds. In another experiment, hydropriming for 6 days at  $15^\circ\text{C}$ , in *Helichrysum bracteatum* accelerated emergence (Grzesik & Nowak, 1998). While, Pill and Necker (2001) found that hydropriming failed to improve emergence in common Kentucky bluegrass seeds. These findings support the earlier work of Basra *et al.* (2002) and Shahbaz *et al.* (1998), who

reported enhanced seedling establishment in hydroprimed canola and sunflower, respectively.

Improved plant population is probably the result higher final emergence percentage (Table I). Seed priming treatments resulted in increased head diameter, which resulted in higher number of achenes per head as is evident from the positive correlation between head diameter and number of achenes per head (Fig. 2). Seed priming might have resulted in enhanced nutrient supply towards the developing achenes that resulted in higher 1000- achene weight (Table II). Improved biological yield as a result of seed priming might be due to earlier and uniform emergence (Table I), which ended in increased biological yield (Table II) improved achene yield from primed seeds seems the result of improved yield contributing factors i.e. plant population, head diameter, number of achenes per head and 1000- achene weight (Table II) as is confirmed from the positive correlation between head diameter and number of achenes per head (Fig. 2). Earlier and synchronized emergence also seems the basis of improved achene yield from primed seeds as proved by negative correlation between MGT and achene yield (Fig. 1). Improved harvest index by seed priming might be result of enhanced dry matter partitioning towards the achenes that resulted in improved achene yield. Improved achene proteins seem to be the direct result of higher nutrient uptake from primed seeds, which resulted in bold size that might have contributed towards the improved achene proteins as evidenced by positive correlation between 1000- achene weight and achene proteins (Fig. 3). In a field trial, wheat seeds soaking in 1% sodium bicarbonate solution for 30 min, increased the number of ear bearing tillers  $\text{m}^{-2}$  and gave grain yield of  $4.45 \text{ t ha}^{-1}$  compared with  $4.03 \text{ t ha}^{-1}$  without seed treatment. Soaking wheat seeds in 5%  $\text{NaHCO}_3$  or NaCl for 30 min or 24 h decreased % emergence, tillers and yield (Singh & Gill, 1988). Paul and Choudhary (1991) concluded that wheat seeds primed with potassium salts for 18 h gave higher grain yield than the untreated seed.

From the present study, it may be concluded that seed priming can enhance the seedling establishment, yield and quality of hybrid sunflower. Hydropriming and osmopriming with NaCl were the most promising priming techniques, however, hardening resulted in similar to or even inferior performance than that of untreated seeds.

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