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EFFECT OF SEED PRIMING ON GROWTH PARAMETERS OF SOYBEAN

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Abstract

The beneficial effects of seed priming have been demonstrated for many field crops. The objective of this study was to study the effect of seed priming on growth parameters of soybean (*Glycine max* L.) cv. William-82. For this purpose, experiments were conducted at Khyber Pakhtunkhwa Agricultural University, Peshawar, Pakistan during summer 2003 and 2004. Three seed priming durations (6, 12 and 18 h) and five Polyethylene glycol (PEG 8000) concentrations (0, 100, 200, 300 and 400 g L^{-1} water) along with dry seed (non primed) as control treatment were included in the experiment. Analysis of the two years average data indicated that AGR, CGR decreased with increase in seed priming duration at I_1 during 2003 and AGR, CGR and RGR also showed the same trend at I_1 during 2004. Conversely, RGR increased with increase in seed priming duration at I_2 during 2003. AGR and CGR enhanced with increase in PEG concentration from 0 to 300 g PEG L^{-1} water and thereafter decreased at I_2 during 2003. Primed seed plots recorded higher AGR and CGR as compared with non-primed seed plots at I_1 during 2004 and RGR showed the same trend at I_1 and I_2 during 2003.

Introduction

Soybean (*Glycine max* L., Merrill) is one of the most important protein and oil crop throughout the world. Its oil is the largest component of the world's edible oils. Soybean seed contains 18-22% oil and 40-48% protein. The world production of edible oils consists of 30% soybean. It is an ingredient of more than 50% of the world's high protein meal (Hatam & Abbasi, 1994).

Seed priming has been successfully demonstrated to improve germination and emergence in seeds of many crops, particularly seeds of vegetables and small seeded grasses (Arif *et al*., 2008). The beneficial effects of priming have also been demonstrated for many field crops such as wheat, sugar beet, maize, soybean and sunflower (Khajeh-Hosseini *et al*., 2003; Sadeghian & Yavari, 2004). Basra *et al*., (2003) reported that priming treatment significantly affected growth parameters and recorded an increase in LAI and dry matter accumulation due to priming in canola.

Researchers need to know the dry matter accumulation during the complete growth cycle of a crop. Events along the way may have had a marked influence on the economic yield. One approach to the analysis of yield influencing factors and plant development as net photosynthate accumulation is naturally integrated over time has come to be known as growth analysis. The basic concept and physiological implication in growth analysis are relatively simple and have been explained in the early classic approaches. Growth analysis is frequently used by plant physiologists and agronomists (Gardner *et al*., 1985). Since most of the seed priming work has been done on vegetable and other field crops with little work on soybean, therefore this study was conducted to explore the effects of seed priming on growth parameters of soybean.

Materials and Methods

Experimental site: The field experiments were conducted at Khyber Pakhtunkhwa Agricultural University, Peshawar, Pakistan during summer 2003 and 2004. The experimental site is located at 34° N, 71.3° E and an altitude of 347 m (1138 ft)above sea level a continental climate. The soil of the experimental field was silty clay loam with a clay type montmorillonite, low in nitrogen (0.03-0.04%), low in organic matter (0.7-0.9%) and alkaline in reaction (pH 8.2).

Seed treatment: The seed (8% seed moisture) of soybean cultivar William-82 was primed in 0, 100, 200, 300 and 400 g L^{-1} water polyethylene glycol (PEG-8000) solutions having osmotic potentials of 0, -0.2, -0.5, -1.1 and -1.8 MPa, respectively at 25°C for 6, 12 and 18 h (Michel & Kaufmann, 1973). The control treatment was dry seed (non-primed). The osmotic potentials of PEG 8000 solutions were determined according to Michel (1983). Thereafter, the seed was washed with running tap water (Lee & Kim, 1999). The treated seed was dried back to its original moisture content at room temperature (about 25°C, 45% relative humidity).

Field experiments: The primed seed was sown in the field in first week of May during both years. The control treatment was non-primed (dry seed). The experiments were laid out in randomized complete block (RCB) design and four replications. The plot size of 2 m by 3 m with row to row distance of 50 cm and plant to plant distance of 10 cm was used. One hundred twenty seed were planted in each plot. Two manual hoeing were done for the control of weeds. Plots were irrigated when needed. A basic fertilizer dose of 30:90 kg NP ha^{-1} in the form of urea and triple super phosphate, respectively was applied before sowing. The experiments were harvested in the second week of September during both years. Data were recorded on absolute growth rate (AGR), crop growth rate (CGR) and relative growth rate (RGR).

AGR was calculated from the determined dry matter using the following formula:

$$AGR = \frac{W_2 - W_1}{T_2 - T_1}$$

CGR was calculated from the determined dry matter using the following formula:

$$CGR = \frac{W_2 - W_1}{T_2 - T_1} \; X \; \frac{1}{GA}$$

RGR was calculated from the determined dry matter using the following formula (Gardner *et al.,* 1985):

$$RGR = \frac{\ln W_2 - \ln W_1}{T_2 - T_1}$$

Where

W_1 = Initial weight
W_2 = Final weight
GA = Ground Area
$\ln W_1$ = Natural log of initial weight
$\ln W_2$ = Natural log of final weight
T_1 and T_2 are the time intervals

Statistical analysis: The data were statistically analyzed using analysis of variance technique appropriate for randomized complete block design. Main and interaction effects were compared using LSD test at 0.05 level of probability (Steel & Torrie, 1984).

Results

Absolute growth rate (AGR): AGR decreased with increase in seed priming duration at I_1 (Increase in dry matter weight between sampling at 2nd June to 2nd July) during 2003. Higher AGR was obtained at 6 h seed priming duration followed by seed primed for 12 h. Minimum AGR was obtained for seed primed for 18 h (Fig. 1, a). Greater AGR was obtained for seed treated with 300 g PEG L^{-1} water followed by 200 g PEG L^{-1} water at I_2 (Increase in dry matter weight between sampling at 2nd July to 2nd August) during 2003. Minimum AGR was obtained for water primed seed (Fig. 4, a). Effects of D, C for AGR were not significant at I_3 (Increase in dry matter weight between sampling at 2nd August to 2nd September). The DxC interaction was also not significant for AGR at I_3. Primed seed plots recorded higher AGR as compared with non primed seed plots at I_1 during 2004. AGR decreased with increase in seed priming duration at I_1 during 2004. AGR was the highest at 6 h seed priming duration followed by 12 h and 18 h seed priming duration, respectively (Fig. 1, b).

Crop growth rate (CGR): CGR decreased with increase in seed priming duration at I_1 during 2003. Higher CGR was obtained at 6 h seed priming duration followed by seed primed for 12 h. Minimum CGR was obtained for seed primed for 18 h (Fig. 2, a). Likewise, greater CGR was obtained for seed treated with 300 g PEG L^{-1} water followed by 200 g PEG L^{-1} water at I_2 during 2003. Minimum CGR was obtained for water primed seed (Fig. 4, b). Primed seed plots recorded higher CGR as compared with non-primed seed plots (Fig. 5, b). CGR decreased with increase in seed priming duration at I_1 during 2004. CGR was the highest at 6 h seed priming duration followed by 12 h and 18 h seed priming duration, respectively (Fig. 2, b). The means of D x C interaction indicated that greater CGR was obtained for seed treated with 200 g PEG L^{-1} water for 6 h followed by seed treated with 400 g PEG L^{-1} water for 6 h.

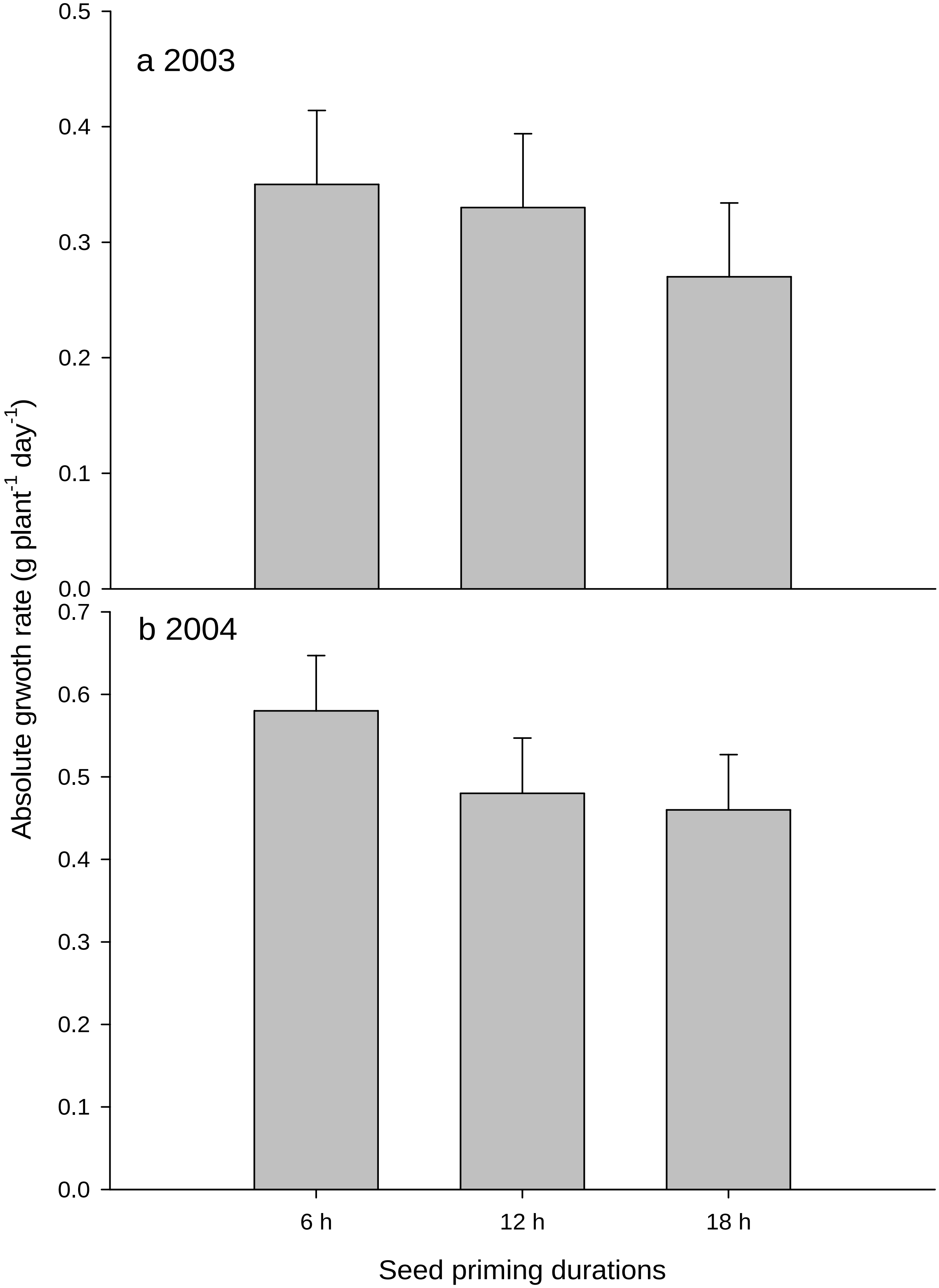

Fig. 1 (a, b). Absolute growth rate of soybean as affected by seed priming duration during 2003 (a) and 2004 (b). Vertical bars denote LSD.

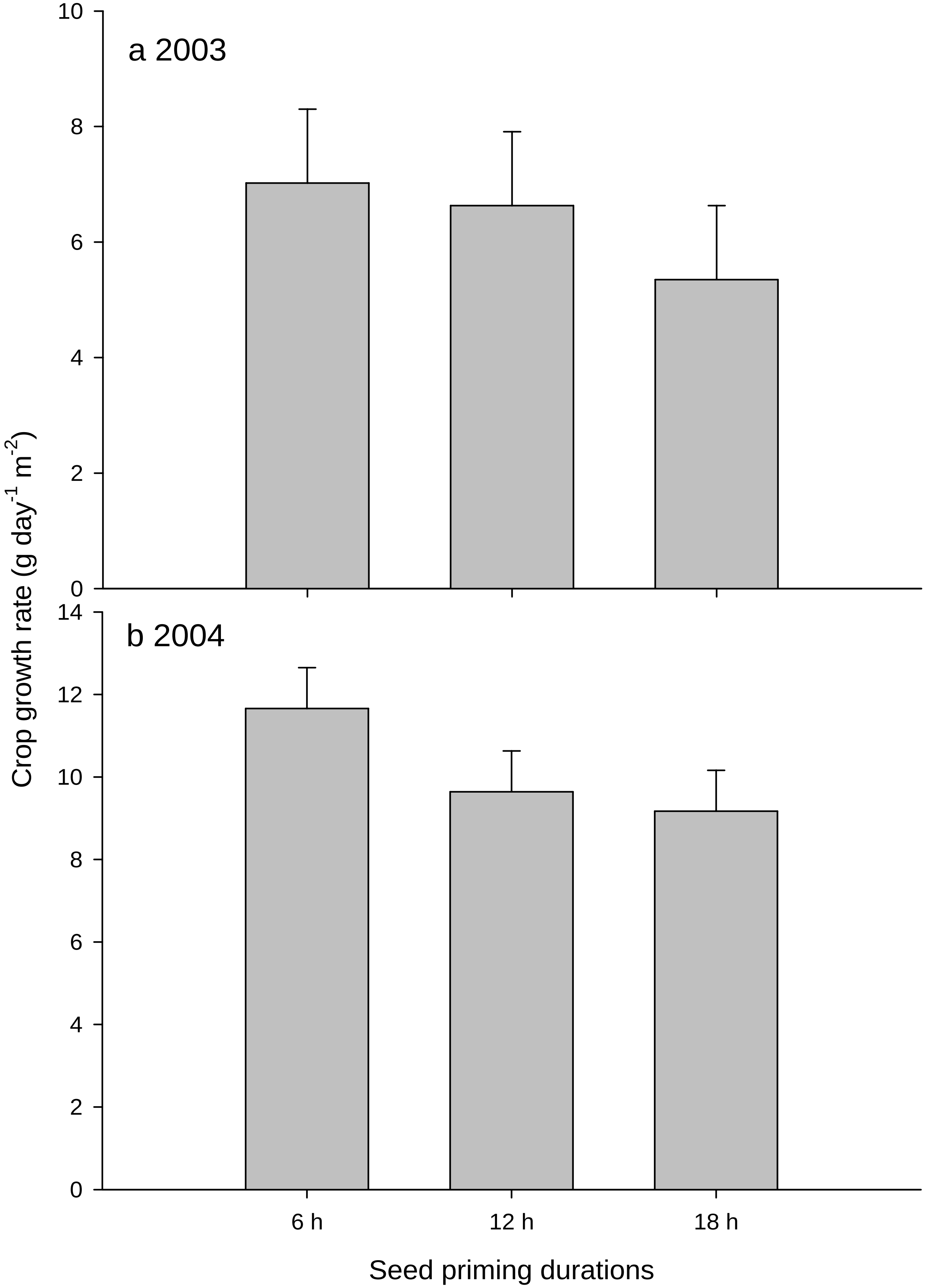

Fig. 2 (a, b). Crop growth rate of soybean as affected by seed priming duration during 2003 (a) and 2004 (b). Vertical bars denote LSD.

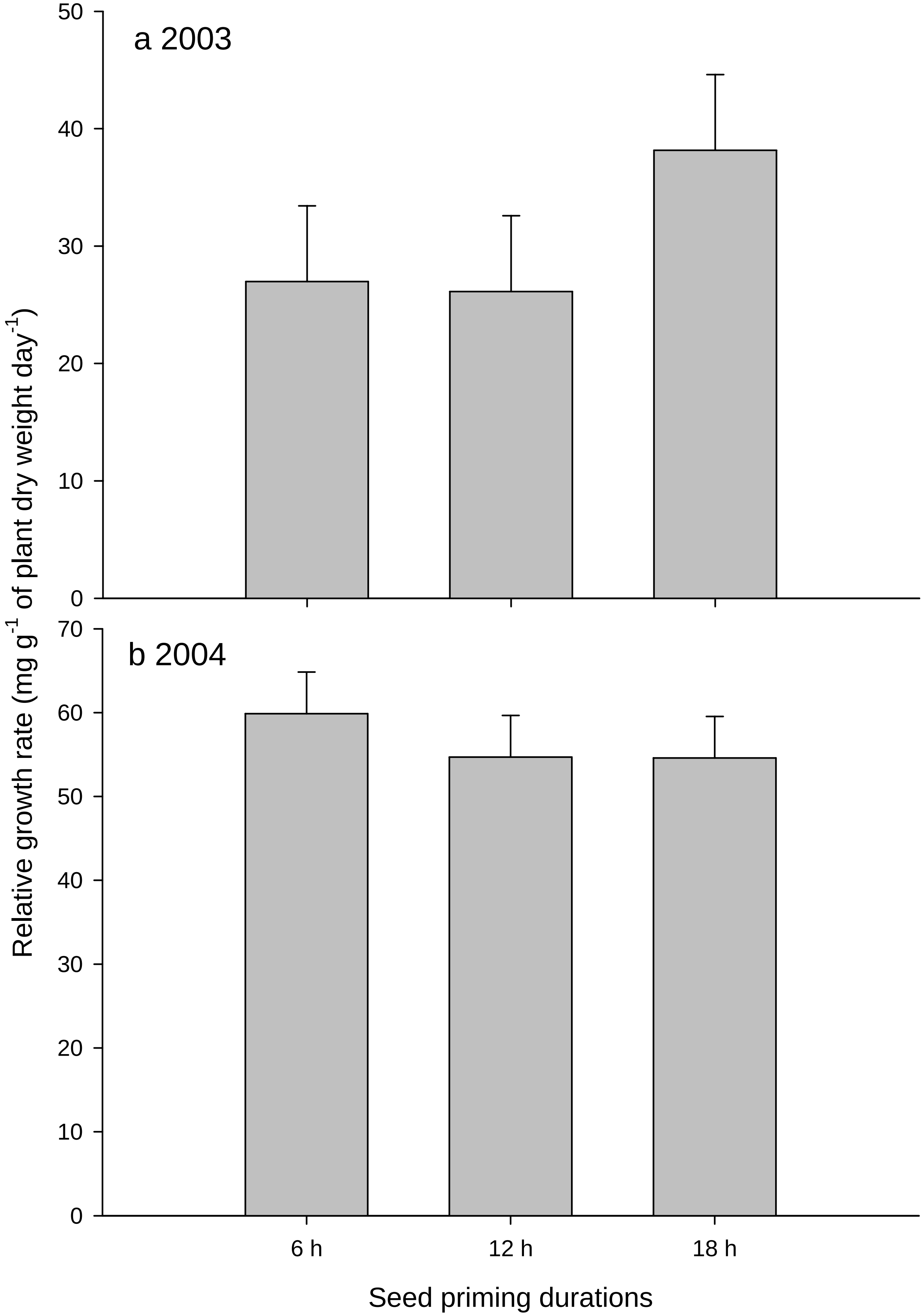

Fig. 3 (a, b). Relative growth rate of soybean as affected by seed priming duration during 2003 (a) and 2004 (b). Vertical bars denote LSD.

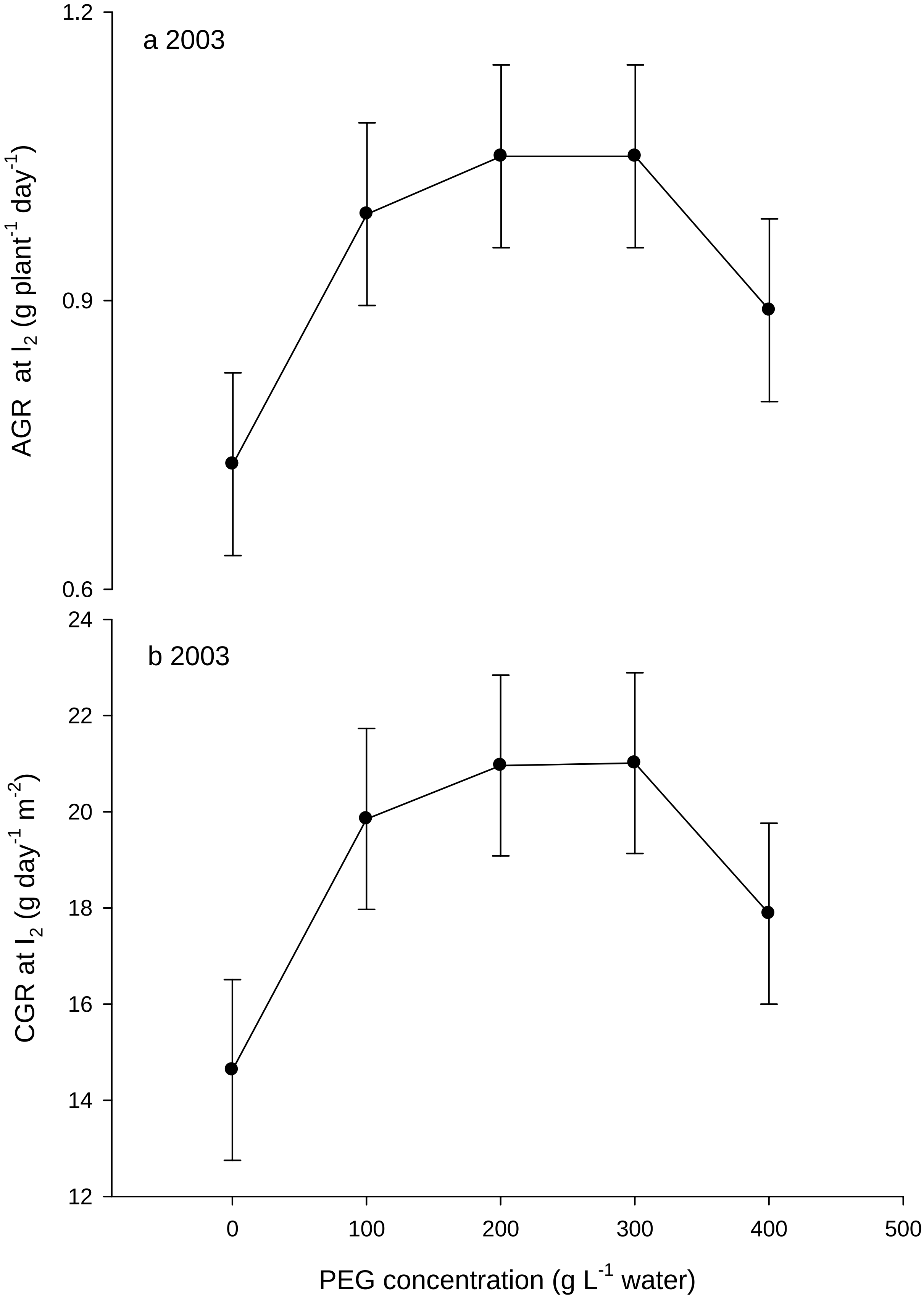

Fig. 4 (a, b).Absolute growth rate (a) and crop growth rate (b) of soybean as affected PEG concentration during 2003. Vertical bars denote LSD.

Relative growth rate (RGR): On the contrary to AGR and CGR, RGR increased with increase in seed priming duration and was higher at 18 h seed priming duration followed by 12 and 6 h seed priming duration (Fig. 3a) at I_2 during 2003. Primed seed plots recorded higher RGR as compared with non primed seed plots at I_1 and I_2 (Fig. 5 c, d). RGR increased with increase in seed priming duration. RGR was the highest at 6 h seed priming duration followed by 12 h and 18 h seed priming duration, respectively (Fig. 3, b).

Discussion

AGR is a major contributor to plant growth. It mainly depends upon plant response to varied climate. It is the dry matter production plant^{-1} day^{-1}. Generally, AGR was slower during the first two months (I_1) of soybean growth and enhanced rapidly during the third month (I_2) and decline again during the fourth month (I_3) of the crop growth. The results agree with the findings of Basra *et al*., (2003) who reported higher dry matter accumulation following seed priming.

Crop growth rate, the gain in weight of a community of plants on a unit of land in a unit time, is used extensively in growth analysis of field crops. A CGR of 20 g m^{-2} day^{-1} is considered acceptable for most crops, particularly C_3 types. As in the case of AGR, CGR was also slower during the first two months (I_1) of soybean growth and enhanced rapidly during the third month (I_2) and declined again during the fourth month (I_3) of soybean growth. These results are in line with Basra *et al*., (2003) who found higher CGR for osmoprimed seed for 8 h. Likewise they further reported that CGR was greater for primed seed sown fresh or after storage as compared to unprimed seed. Similarly, Zhao *et al*., (2007) reported that that presoaking seeds before sowing slightly enhanced vegetative crop growth. This finding corroborate the positive effects of seed priming on emergence and crop growth as reported in previous studies (Harris *et al*., 1999; Bakare *et al*., 2005). However, Subedi & Ma (2005) reported that seed soaking with 20 ppm GA_3 for 16 h significantly reduced the stem dry weight, and whole-plant dry weight at V7.

RGR is major factor to determine plant growth behavior in community or sole. RGR expresses the dry weight increase in a time interval in relation to the initial weight. The RGR does not imply a constant growth rate during a particular t_1 to t_2 time frame; it can vary from instantaneous values of RGR. The RGR of the crop plants generally begins slowly just after germination, peaks rapidly soon afterward and then falls off. Species vary in RGR (Gardner *et al*., 1985). Opposite to AGR and CGR, RGR was also higher during the first two months (I_1) of soybean growth and then declined during the third month (I_2) and fourth month (I_3) of soybean growth. These results agree with Brocklehurst *et al.*, (1987) who reported no effect on RGR by seed priming. The results are also not in line with Murangu *et al*., (2004) who reported that priming did not affect the relative growth rate of cotton or maize. Likewise, Brocklehurst *et al*., (1984) found that earlier emergence after priming gave rise to higher mean plant weights ten weeks after sowing in leek but there was no effect of priming on seedling relative growth rate under controlled conditions.

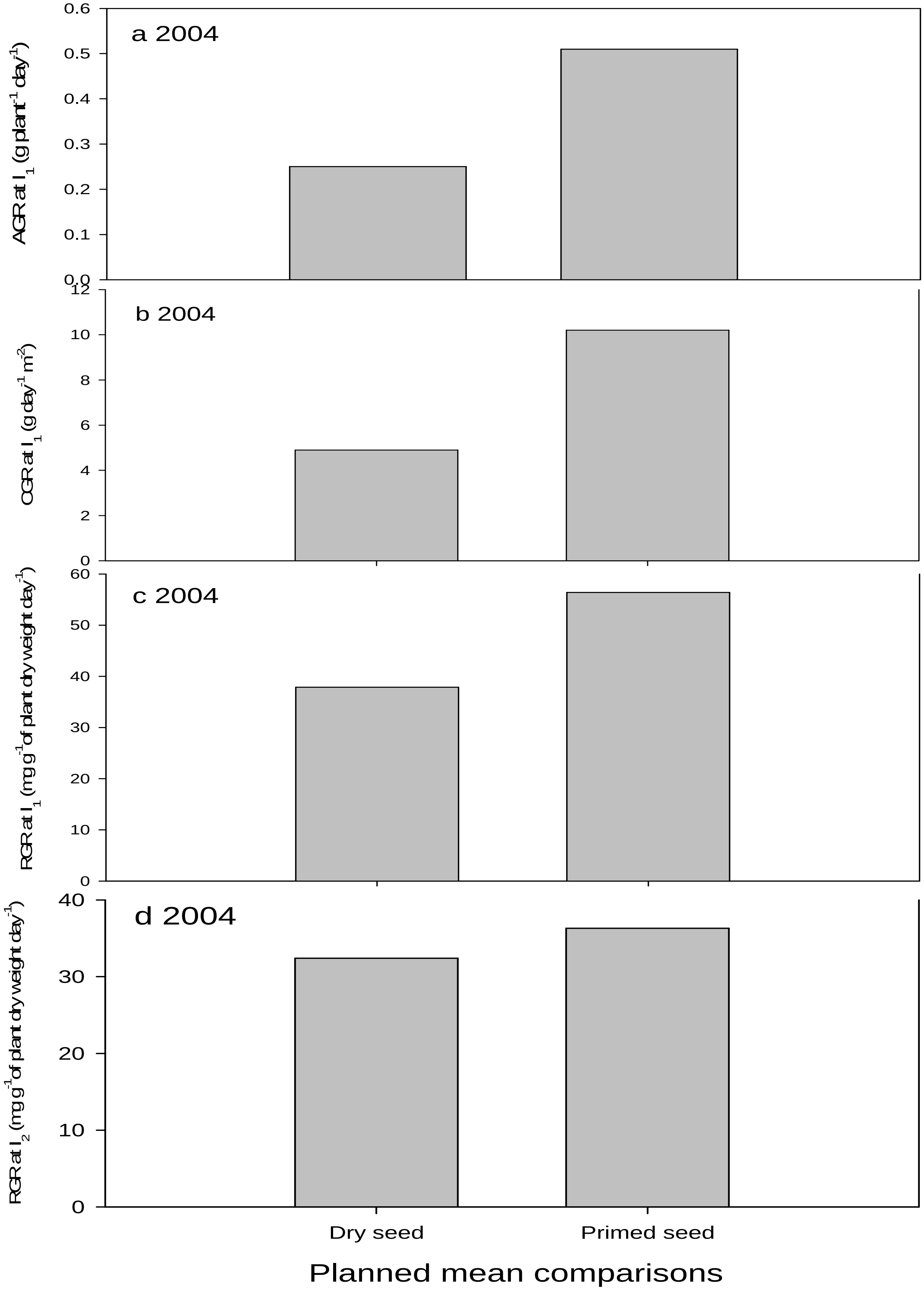

Fig. 5 (a, b, c, d). Dry seed vs. primed seed for absolute growth rate (a), crop growth rate (b) and relative growth rate (c, d) of soybean during 2004.

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