Evaluation the Effect of Foliar Absorption of Glycine Betaine on Physiological Characteristics of Rapeseed Cultivars (*Brassica napus*)

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Abstract

Iran's Situation in the belt of Northern hemisphere is drought with reduction and descending rainfall and other atmospheric conditions that are brought different complicacy for farmers. In recent years valuable steps has taken to reduce water consumption or to optimize it. One of these methods is the application of osmolytes such as Glycine betaine.To study, the effects of four application levels of Glycine betaine on three rapeseed cultivars in Mashhad, Iran 2009, an experiment was conducted as factorial format based on Randomized Complete Blocks Design with four replications. The experimental factors were three rapeseed cultivars i.e. Hayola 401, Zarfam and Okapi combined with four applications of Glycine betaine (0, 3, 6 and 9 Kg/ha). Irrigation time was selected as after sixty percent of field capacity. The results showed that the effect of characteristics such as grain yield, number of pods, number of kernels per pod and leaf area index were significant($P \leq 0.01$),and also for relative growth rate and net assimilation rate ($P \leq 0.05$). Hayola 401 had maximum LAI, but it had the lowest NAR. Glycine betaine was not significant effect on the crop growth rate. However, it had significant effect on NAR at $P \leq 0.01$, and increased this character for Hayola 401. When this cultivar was treated with 6 kg/ha Glycine betaine, Showed superiority in yield compared to other treatments with 4473/19kg/ha seed yield.

Key Words: *Seed yield, Osmolytes , Leaf Area Index, Net Assimilation Rate, Crop Growth Rate*

Introduction

Rapeseed (*Brassica napus* L.) from the family " *cruciferae* " is one of the most important oilseed crop, that the surface area under its cultivation has increased recently in Iran. This crop is a valuable source of oil and protein. Amongst environmental factors affecting the oil content of rapeseed , temperature play a significant role and has negative relationship with oil percentage. Irrigation can be increased the oil content in the seed (Kerogman and Hobbs, 1975) whilst flooding (Cannell and Belford, 1980) and water stress (Mailer and Cornish, 1987) be reduced. For this reason proper selection of cultivar is of importance for production success (Thurling, 1991). Mendham et al (1981) showed that the development rate is related to mean temperature from flowering to physiological maturity and the flowering length in field depends on cumulative GDD along the phonological stages. Clarck and Simpson (1978) showed, crop growth rate has a linear relationship with leaf area index so that with increasing the LAI, it increasing too. The crop with LAI=4 can intercept almost 90% of incident radiation (Mendham et al, 1981). Robinson and Jones (1986) recorded, Glycine-Betaine have a effective role in stress resistance. This material is a buffer solution in most of plant species (Rhodes and Hanson, 1993). It is either as a osmoprotectant or has different physiological effect in response to plant stresses (Kishitani et al, 2000). Compatible solutes have a important role in osmotic adjustment (Jones,1980). Also the ability of cells to maintain their wall situation in normal conditions, Leads to stop the protein degeneration (Gaff, 1980). Plants encountered to osmotic stressors, accumulate some contents of protein, soluble sugars and etc (Naidu et al 2006). Compatible solutes are soluble materials that have no diverse cytoplasmic effect , even in high concentrations and are accumulated for adaptation to stresses(Kunte, 2000). Osmolytes such as GB and Maorine resulted to clear the cell media from free oxygen radicles (Schwaclce et al, 1999). GB reduce the peroxydation of lipids in plants (Cushman, 2001). Scientists think this positive effects of GB is relevant to free amino acids and soluble sugars (Quan et al 2004). This research was conducted for evaluation the response of different cultivars of rapeseed to GB levels. We suggest that in the water crisis conditions of Iran, can find some compatible cultivars with treatment of GB and then improve the quantitative and qualitative traits of rapeseed in un-proper areas.

Material and Methods

This experiment was performed as factorial trial base on RCDB design with four replications in Mashhad, Iran. Planting date was 15/9/2009. Cultivars were: Hyola401, Zarfam and Okapi, and the levels of Glycine- Betain (GB) included of 0, 3, 6 and 9 Kg/ha that was sprayed in 12 leaves stage. Irrigation was adjusted based on %60 water depletion from field capacity for all cultivars. During the growing season, and also in maturity some samples were took for determination Of growth indices (

CGR, LAI, RGR, NAR) and yield and yield components. Statistical analysis was performed via SAS program and means were compared with Duncan multi range test.

Results

Cultivars were significantly different for LAI. The greats LAI obtained in Hyola401. This cultivars with a LAI equal to 4.72 was superior compared to the two other ones. Application of GB had no distinict effect on LAI variation. But the interaction effect Okapi× 3 kg/ha GB showed the greatest LAI. The higher NAR belonged to Okapi and the lowest one to Hyola401, with the rate of 6.22 and 5.01 $g.m^{-2}.day^{-1}$ respectively. The treatment of 6kg/ha GB on Hyola401, led to the greatest interactive effect for NAR equal to 6.37 $g.m^{-2}.day^{-1}$. It seems that the effect of GB in time of hot temperature occurance resulted to increased NAR for Hyola401. GB had no effect on CGR but had significant effect on RGR ($P \leq 0.05$).

Seed yield showed significant difference ($p \leq 0.01$) between cultivars and GB levels. Amongst cultivars, Okapi had the highest seed yield with 4312.14 Kg/ha (Figure 1). Application of 6 Kg/ha GB, increased seed yield too (Figure 2).

Interaction effect for Hyola401 ×6 kg/ha GB increased yield up to 4473.2 kg/ha .Figure 3 , shows cultivar differences for pods/plant that was significant in 0.01 level , but GB had no effect.

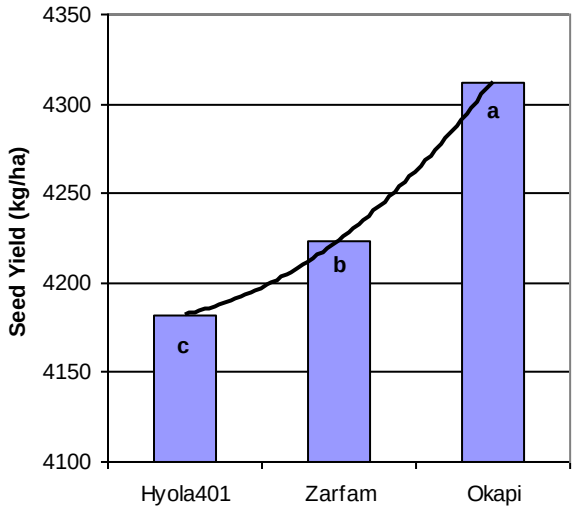

Figure 1: Effect of cultivars on seed yield

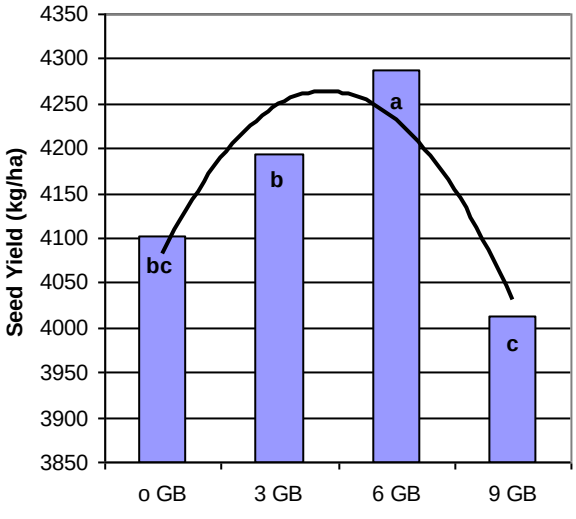

Figure 2: Effect of GB on seed yield

The greatest of pods/plant obtained for Hyola401 * 6 kg/ha GB . Number of seed per pod in cultivars and GB levels was significantly different ($p \leq 0.05$) . This yield component was increased with 3 and 6 kg/ha GB (Table 1). 1000seed weight also affected from cultivar and GB. Okapi with 4.43 g had the highest rates . Application of 9 kg/ha GB, reduced seed weight .

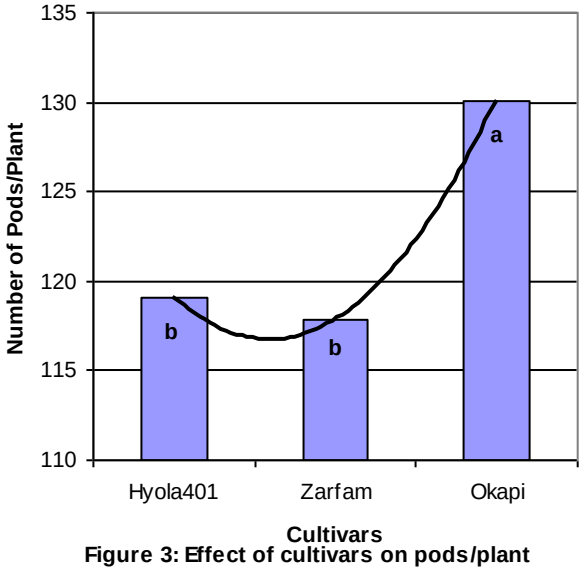

Figure 3: Effect of cultivars on pods/plant

Table 1: Effects of intraction of GB×Cultivars on number of seed/pod

Cultivar/GB	0 kg/ha	3 kg/ha	6 kg/ha	9 kg/ha
Hyola401	22.18	23.01	26.13	23.72
Zarfam	22.33	22.81	24.83	22.89
Okapi	25.73	25.98	26.38	25.81

Increased yield in okapi was related to long vegetative period , increasing photosynthetic area and accumulated nutrients . However the pods and also empty pods in this cultivar were increased . It seems that the reaction of cultivars to GB has genetic basis , and early maturing cultivars shows proper reaction to warm temperatures. Using these cultivars with application of GB can be a good choice for water limited areas with a reasonable yield.

References

Cannell, R.Q., and R.K. Belford. 1980. Effects of waterlogging at different stages of development on the growth and yield of winter oilseed rape (*Brassica napus* l.) J. Sci. Food & Agtric. 31: 963-965.

Cushman, **J. C.** 2001. Osmoreglution in plants: Implications for agriculture. Amer. Zool. 41: 758- 769.

Clarck, J.M., and G. M. Simpson. 1978. Growth analysis of *Brassica napus* cv. Tower. Can. J. Plant Sci. 58: 587-595.

Gaff, **D. F.**1980. Protoplasmic tolerance of extreme water stress. *In:* Adaptation of plants to water and high temperature stress. (pp:207-230), Turner, N. C., and P. J., Karmer,(Eds.), Willey. New York.

Jones, **H. G**. 1980. Interaction and integration of adaptive responses to water stress: The implications of an unpredictable environment. *In:* Stress Physiology in Crop Plant. (pp: 408-428), Mussell, H. and R.C., Staples, Eds., Willey, New York.

Kishitani, **S., T.Takanami, M.Suzuki, M.Oikawa, S.Yokoi, M.Ishitani, A.M.A.Nakase, and T. Takabe.** 2000. Compatibility of glycin betaine in rice plants: Evaluation using transgenic rice plants with a gene for peroxisomal betaine aldehyde dehydrogenase from barley. Plant Cell Environ. 23: 107-114.

Kerogman, K., and E.H. Hobbs. 1975. Yield and morphological response of rape (*Brassica compestris* L. cv. Span) to irrigation and fertilizer treatments. Can. J. Plant Sci. 55: 903-909.

Kunte, **H. J**. 2006. Osmoregulation in bacteria: Compatible solute accumulation and osmosensing. Environ. Chem. 3: 94-99.

Mailer, R. J. and P.S. Cornish. 1987. Effects of water stress on glucosinolate and oil concentrations in the seeds of rape (*Brassica napus* L.) and turnip rape (*Brassica rapa* L. var. Silvestris[Lam.] Briggs). Aust. J. . Exp. Agric. 27: 707-711.

Mendham, N. J., P.A. Shipway, and R.K. Scott. 1981. The effects of delayed sowing and weather on growth, development and yield of winter oilseed rape (*Brassica napus L.*). J. Agric. Sci. Camb. 96: 389-416.

Naidu, B. P.,D.F. Cameron, and S.V. Konduri. 2006. Improvement drought tolerance of cotton by Glycine betaine application and selection. The Australian Agronomy Conference.

Quan, R., M. Shang, H. Zhang, Y. Zhao, and J. Zhang. 2004. Engineering of enhanced Glycinebetaine synthesis improves drought tolerance in maze. Plant Biotec. J. 2: 477-486.

Rhodes, D. and A.D. Hanson.1993. Quaternary ammonium and tertiary sufonium compounds in higher plants. Ann. Rev. Plant Physiol. Plant Mol. Biol. 44: 357-384.

Thurling, N. 1991. Application of the ideotype concept in breeding for higher yield in the oilseed Brassicas. Field Crops Res. 26: 201-219.

Yordanov, L., V. Velikana, and T. Tsonev.2003. Plant responses to drought and stress tolersnce. Bulg, J. Plant Physiol. Special issue. 187-206.