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Foliage applied selenium improved the productivity and quality of white mustard under arid climate

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ABSTRACT

Oilseeds crops have a strong bearing on the national economy as they constitute about 5 percent of total imports and 50% of agricultural imports. Productivity enhancement of oilseeds, therefore, is of vital importance. Our national consumption of edible oils is around 1.95 million tonnes, of which about 70% is met through imports. Due to these reasons, it is very necessary to enhance the area as well as the productivity of oilseed crops. Therefore; a study was carried out to evaluate the productivity and quality of white mustard by exogenous application of selenium under an arid climate of Thal at Agronomic Research Area, BZU, Bahadur Sub-Campus Hafizabad Layyah Pakistan, during the year 2016. This experiment was conducted using the RCBD with split plot arrangements. The results revealed that the plant height, stem diameter, 1000-seed weight, seed and biological yield were significantly improved by selenium at Thal region.

INTRODUCTION

White mustard (*Sinapis alba* L.) is an emerging oilseed crop belongs to *Brassicaceae* family. White mustard is being considered as an alternative oilseed crop for dry and low rainfall climates. It possesses many beneficial characteristics such as pest resistance and a short growing season (Bodnaryk and Lamb, 1991). In cold climates, white mustard (*Sinapis alba* L.) is a spring annual crop, thus may fit well in winter under local climatic conditions. Moreover, it may be well adapted to hot, dry growing conditions. Heat and drought tolerance of white mustard is superior compared to rapeseed or canola (*B. napus* or *B. rapa*). It has 55% higher seed yield than spring canola in regions that receive less than 12 inches of annual precipitation. White mustard plants have an extensive root system that penetrates deep into the soil profile. More than 50% of all moisture uptake is from below 5 feet in the soil profile and hence can utilize nitrates those have leached down from other crops

(Brown *et al.*, 2002). White mustard is highly competitive with weed species. In crop-weed competition studies, it has been shown that one wild oat plant was as competitive as four canola plants whereas one white mustard plant was more competitive than two wild oat plants (Duke, 1978).

Presence of less yielding and disease/pest resistant varieties, the low area under oilseed cultivation, shattering losses, the competitiveness of sowing season of oilseed crops with major crops, less access to market and less awareness among the farmers are the reasons for low oil production in Pakistan. However, low water requiring crops such as white mustard having ability to germinate under low temperature may be grown in this scenario. White mustard is one of the most important oilseed crop occupying the fourth place in the world (Rodrigues *et al.*, 2002) and is grown on 22 million ha in the world and producing about 33 million tons of white mustard seeds annually (FAO, 2014). White mustard is

being considered as an alternative oilseed crop for dry and low rainfall climates. Pakistan although, contains good fertile lands and enjoys favourable weather, still have a very large difference between the per unit yield as compared to other countries of the world. There are various factors that affect the yield of white mustard in Pakistan. Most common factors that cause the low yield are low quality seed (Anderson, 1993), non-availability of irrigation water in time (Xiong, 1998), poor seedbed preparation (Zarcinas et al., 1987), and late sowing (Ward et al., 2009).

Selenium is an essential element for many organisms; however, selenium isn't mentioned as an essential element (Galeas et al., 2007; Ferri et al., 2007; Terry et al., 2000). The plants show a variety of physiological responses and some species do store large amounts of selenium in themselves. But selenium is toxic to some plants so that these plants are so susceptible to large amounts of selenium in soil and water (Terry et al., 2000). In general, selenium is an essential element for thirty selenoenzymes and selenoprotein and it is an important component of enzymes that protect the cells against free radicals. Also, incorporation of selenium into proteins protects the tissues and membranes against oxidative damage (Terry et al., 2000; Neuhierl and Böck, 2004). Although selenium is an essential element for plants, it is not necessary and even toxic. But nonetheless, low concentrations of selenium have beneficial effects on the metabolism of plant cells and regulates the absorption of some ions. Thus, the present study was aimed to enhance the productivity of white mustard through foliar application of Se.

MATERIALS AND METHODS

Site description: This field experiment was conducted at the Agronomic Research Area, Bahauddin Zakariya University, Bahadur Sub Campus Layyah during 2016-17.

Experimental treatments and experimental design: The experiment was laid out in a randomized complete block design (RCBD) with 3 replications. The experiment consisted of following treatments;

Treatments: Selenium (Se) levels

T₁ = 0 (control)

T₂ = 2 mM

T₃ = 4 mM

T₄ = 6 mM

Crop husbandry: Before sowing of the seed, the field was properly levelled. When the soil reached proper moisture

level, it was ploughed three times followed by planking. After seedbed preparation, the crop was sown in 25 cm apart rows with single row hand drill using a seed rate of 10 kg ha⁻¹. Fertilizer was applied @ 120-100 kg NP ha⁻¹. The whole of the phosphorus and one-third of the nitrogen was applied as a basal dose. Remaining nitrogen was applied with first and second irrigation in equal splits. All other agronomic practices were kept normal and uniform for all the treatments. The crop was sown on November 03, 2016. Thinning was done on December 18, 2016, to maintain plant population. Weeding was also done manually to remove the weeds. The climate of the area is was arid. The soil was sandy loam. Row to row distance was 30 cm and the net plot size was 1.8 m × 5m.

Data Recording: Data on plant height, number of leaves, stem diameter, biological yield, and seed yield was recorded following the standard procedures. The crop became fully matured in the last week of March. When 90% heads become brown, the harvesting was done.

Statistical analysis: The collected data were analyzed statistically using computer software STATISTIX 8.1. Significance of variance was tested by using analysis of variance technique and the differences among treatment means were compared using LSD test ($p = 0.05$). Data were presented graphically using the excel sheet. Standard error was computed for comparison of treatments and parallels were drawn for growth and development.

RESULTS

Plant height (cm): Exogenous application of selenium at variable levels significantly affected the plant height. Among the selenium treatments, the highest plant height was recorded when selenium was foliage applied at the rate of 6mM and that was statistically similar to the application of selenium at 4mM (Table 1).

Stem Diameter (cm): Exogenous application of selenium at variable levels significantly affected the stem diameter. Among treatments, maximum stem diameter was recorded at the rate of 4mM followed by selenium application at 2 mM and 6 mM, respectively (Table 1).

Number of leaves per plant: Among Se levels, the minimum number of leaves was recorded at the highest rate of Se (6 mM) as compared to the lowest level (control) of Se.

Biological Yield: Se treatments showed a significant effect on biological yield of the white mustard crop as shown in table 1. The maximum biological yield was recorded at the highest level of Se (6 mM) as compared to

the lowest rate (control) where no Se was applied.

Seed yield: Among Se treatments, the maximum seed yield (SY) was found at 4 mM of Se followed by 2 and 6

mM, respectively (Table 1). On the other hand, the lesser straw yield was recorded in the control plot.

Table 1. Influence of various selenium levels on growth and yield component of white mustard crop grown in Thal Region.

Treatments	Plant height (cm)	Stem diameter (cm)	Number of leaves per plant	Biological yield	Seed yield
Control	159.22 C	2.53 B	2.24 C	1650.4 D	2.53 B
2mM	166.31 B	2.87 A	2.41 BC	1795.3 C	2.87 A
4mM	174.07 A	2.97A	2.48 B	1894.0 B	2.97 A
6mM	177.82 A	2.84 A	2.66A	2032.0 A	2.84 A
LSD (0.05)	9.7	0.80	0.2	30.9	0.18

DISCUSSION

This study indicated that selenium application significantly improved the morphological and yield and yield related to white mustard. Selenium application at a high level was most beneficial. Indeed, selenium is an essential element for many organisms; however, selenium isn't mentioned as an essential element (Galeas et al., 2007; Ferriert al., 2007; Terry et al., 2000). The plants show a variety of physiological responses and some species do store large amounts of selenium in themselves. In general, selenium is an essential element for thirty selenoenzymes and selenoprotein and it is an important component of enzymes that protect the cells against free radicals. Also, incorporation of selenium into proteins protects the tissues and membranes again oxidative damage (Terry et al., 2000; Neuhierl and Böck, 2004). Although selenium is an essential element for plants, it is not necessary and even toxic. Nonetheless, low concentrations of selenium have beneficial effects on the metabolism of plant cells and regulate the absorption of some ions. Plants treated with selenium increases the number of enzymes, eliminators of H₂O₂ (particularly ascorbate peroxidase and glutathione peroxidase) and antioxidant compounds (such as ascorbate, glutathione and proline (Quinn et al., 2010; Djanaguiraman et e., 2004; Krzysztof al., 2008) and that is why selenium can reduce the amount of H₂O₂ in plants (Freeman et al., 2006). Studies have shown that the soil in some areas (such as Northern Europe) are facing with selenium deficiency (Gao, 2000; Searcy and Macnair, 1990). Selenium foliar application increased the number of antioxidant enzymes and drought resistance raises (Dhillon, 2009). Thus, selenium application at 6 mM might opt.

CONCLUSIONS

The results revealed that the plant height, stem diameter, 1000-seed weight, and biological yield were significantly improved by selenium application.

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