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Original Research

Exploring the potential of Selenium (Se) and Moringa (*Moringa oleifera* L.) leaf extract on the production and performance of *Triticum aestivum* L.

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ABSTRACT:

Selenium (Se) is a fundamental trace element present in the living organisms and has a high impact on human health, animal and plants. Due to the antioxidant property, selenium plays a vital role in enhancing the growth of plants. With respect to natural plant growth stimulants, *Moringa oleifera* L. had attained much importance having leaves enriched with micro and macro nutrients, antioxidant and cytokinin when applied in low concentration and influenced the agronomic growth. A research was laid to explore the potentials of *Moringa* leaves allelopathic extract and selenium (Se) on the production of wheat. The research was laid out in Randomized Complete Block Design (RCBD) with four replications having net plot size dimension *i.e.* 5 m × 1.8 m. Various data such as stand establishment and germination data were recorded by recommended protocols and analyzed statistically by using Fisher's analysis of variance techniques and treatment means were compared by using LSD (Least Significant Difference test) having 5% level of probability. Results concluded that foliar application of selenium significantly influenced the recorded attributes of wheat. Harvest index, biological yield, grain yield, thousand grain weight, grain per spike, spike length and total tillers were improved upto 15.18%, 8.85%, 25%, 18.52%, 18.91%, 26% and 11.94% respectively by foliar application of selenium (Se) with respect to the control. The study concluded that utilization of selenium as seed coating, seed priming or as foliar application in cropping system must be done in order to maximize the production of cereals for overcoming the issue of food security.

Keywords:

Selenium, Antioxidant, Bio-stimulants, *Moringa* leaf extract, Wheat.

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INTRODUCTION:

Wheat (*Triticum aestivum* L.) is considered as the vital grain crop, cultivated almost every part in the world. It is one of the leading resources of carbohydrates, so almost one third of the world's total residents uses it as staple food item. In Pakistan, wheat plays first position with references to the cereal crops. Wheat plays an important part in national GDP of Pakistan *i.e.* 1.9% shares in GDP. In 2016-2017, wheat was sown approximately on an area of 9.6 million hectares and 27.5 million tons in its total production (Government of Pakistan, 2017). Despite of the fact that, Pakistan has achieved a position to meet their own demand of wheat, but the average yield of wheat in Pakistan is fewer as compared to the rest nation producing wheat (Breznik *et al.,* 2005). Causes of low output of wheat contributes different dynamics like climatic condition, improper husbandry practices, low fertility of soil (Tahir *et al.,* 2009) and in appropriate nutrient supervision (Ali *et al.,* 2008) also play apart for low yield.

With the gradual boost in world population, food security is believed a vital issue. To meet the current issue, it is compulsory to maintain such an agricultural system, which comprises of such most recent techniques which enhances crop yield and sort the food security issue (Avis *et al.,* 2008). Almost 30-50% crop yield is due to the contribution of artificial nutrient inputs (Stewart *et al.,* 2005). Despite of that, exogenous valuable micronutrient, natural and artificial growth promoters can play apart in maintain plant growth and development. Growth and development of the plants were positively influenced by applying plant hormones/ plant growth regulators (Khan *et al.,* 2008; Ali *et al.,* 2011).

Selenium is an important trace nutrient, which exists in every kind of soil, but generally such type of soils which having high iron, low pH are leached soils with less availability of selenium. Usually, selenium occurs in four oxidation states such as selenides (Se^{-2}), selenate (Se^{+6}) Se elemental (Se^{0}) and selenite (Se^{+4}). Clay contents and pH of soil greatly influenced the availability of selenium (Gissel-Nielsen and Bisbjerg, 1971; Mikkelsen *et al.,* 1989; McNeal and Balistrieri, 1989). Selenium plays a vital role in the plant metabolism. Species like sorghum, bitter gourd, potato, soybean and ryegrass etc. had positive outcome in terms of plant growth and germination by proceeding selenium application in the soils (Carvalho *et al.,* 2003). Expansion of growth was noticed surely by selenium application in Indian mustard Singh *et al.* (1980) also in wheat Peng *et al.* (2001) and in rice as well (Wu, 2004). The media enriched with selenium showed strong resistance against photo-oxidative stress especially in vegetables plants (Seppanen *et al.,* 2003; Breznik *et al.,* 2005)

Natural occurrence of production and release of secondary metabolic chemicals are generally termed as allelopathy (Rice, 1984). Allelochemicals generally promote or inhibit the growth of companion plants present within the field (Jalili *et al.,* 2007). Chemicals like zeatin (part of cytokinin) present excessively in the leaves of *Moringa oleifera* (El-Awady, 2003) Moringa has achieved great importance in current days due to its multidimensional benefits which concerned with the industry and agriculture (Ashfaq *et al.,* 2012). Chemicals which have the ability to enhance growth like phenolic, ascorabtes and minerals like (calcium, potassium and iron) are abundantly occurred in the leaves of moringa (Anjorin *et al.,* 2010).

Some scientists considered moringa leaf extracts as the best for plant growth promotion, which increased 94% and 65% yield in raddish and bean correspondingly (Foidle, 2001). Increased growth and yield of certain agronomic crops *i.e.* maize and bean was observed by applying Moringa extracts in the respective crops (Mvumi *et al.,* 2013). The certain plant parameters like rate of germination, plant height, leaves per plant, plant dry weight and grain yield were progressed by utilizing Moringa extracts on the crops (Hossain *et al.,* 2012).

Similarly, in wheat, the crop parameters like 1000 grain weight, biological output, cereal yield and harvest index (HI) were far better by foliar utilization of Moringa extracts when crop is at the heading stage with respect to the control (Basra *et al.,* 2011). So, as mentioned above, the significance of selenium and Moringa extracts, the current trail was proposed to evaluate the function of selenium by numerous application methods (seed coating, seed priming, along with foliar application) and also utilizing allelopathic Moringa extracts to explore the performance of wheat (*Triticum aestivum* L.).

MATERIALS AND METHODS

This research was conducted at the student's research farm, Department of Agronomy, University of Agriculture, Faisalabad, (31^0N, 73^0E and 184.4 mean sea level) in Pakistan during the year 2012-2013. This experiment comprised of randomized complete block design layout consisting of four replications. Net plot size of each treatment was 5 m × 1.80 m. Each treatment was properly tagged to diminish the probability of error. The experiment was established in the mid week of November, following standard agronomic measures. The experiment was conducted the following the procedure stated below:

Seed priming

For the purpose of seed priming, a solution of selenium having 1.25 mM concentration was made and then wheat seeds were soaked in the solution in aerated condition. Aeration was provided by aquarium pump during the soaking of wheat seed. Wheat seeds were soaked for 12 h in the Moringa extracts solution having a ratio of 1:5 (w/v). Primed seeds were dried for 24 h after removing from their respective solution, and then packed in polythene bags along with proper tagging.

Seed coating

Arabic gum was utilized as a coating for wheat seeds. 1 mL water, 2 g Arabic gum and 500 mL selenium were mixed together for coating. Arabic gum and selenium were heated up to induce the formation of slurry form. Then seeds were added and mixed properly and dried for 24 h, then stored in polythene bags along with the proper tags.

Preparation of Moringa extracts and foliar application

After harvesting the Moringa leaves from student farm, U.A.F, Faisalabad, its extract was made according to Price (2007), by grinding fresh leaves including young shoots along with the minute quantity of water (1 L for 10 Kg fresh plant material) in Fabricated Extraction Machine in Allelopathy Lab, Department of Agronomy, University of Agriculture, Faisalabad, Pakistan. Distilled water was used to prepare extracts for foliar spray. After following the above stated protocols following treatments were made.

T_0 = Control

T_1 = Osmo-priming with Se at 1.25 mM concentration

T_2 = Seed coating with Se (500 mg Kg^{-1})

T_3 = Foliar application with Se (100 g ha^{-1})

T_4 = Foliar application of Moringa extract at jointing

T_5 = Foliar application of Moringa extract at anthesis

Experimental trail was examined daily. During the trail, following parameters were recorded.

Emergence count

In each plot two spots were randomly marked, according to the seedling estimation (AOSA, 1993), number of seedlings which were emerged counted on daily basis up to persistent number of seedlings were viewed. After finalizing the emergence from individuals plot, final emergence was calculated.

Mean Germination Time (MGT (days))

By utilizing Ellis and Robert (1981) equation, mean germination time MGT was recorded:

$$MGT= (\sum Dn/ \sum n)$$

where, 'n' stands for number of seeds that were germinated on the day 'D' and 'D' stands for number of days counted from the starting of seed appearance.

Time taken for 50% emergence ((E_{50}) days)

This term can be defined as time taken to half of seedlings to emerge out. It was calculated by formulae proposed by the Coolbear *et al.* (1984) which was 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' stands for final number of seeds emerged, 'n_i' and 'n_j' is equal to cumulation of seed number germinated by adjoining counts at 't_i' and' t_j' so 'n_i'<N/2 and <n_j.

Germination index

Germination index GI was recorded by pursuing the formulae as revealed by AOSA, (1983):

$$GI = \frac{\text{number of seeds emerged}}{\text{days of initial count}} + \ldots + \frac{\text{number of seeds emerged}}{\text{days of last count}}$$

Plant height

First ten plants were picked randomly from each treatment and then with the help of meter rod height of each plant was measured from the plant base to its tip of the ear.

Number of tillers

By utilizing quadric quantity of tillers was recorded per unit area of each treatment at the time of harvest.

Number of productive tiller

It was also counted from final harvest of individual treatments.

Spike length

Randomly five spikes from each treatment were picked, and then with the help of meter rod spike length was measured separately and then averaged (Nawaz *et al.,* 2013).

Number of Spikelets per spike

The already selected spikes were utilized to count the number of spikelets per spike and then average was recorded.

Number of grain per spike

Already selected spikes were threshed manually and grains per spike were counted and at the end mean value was taken.

Thousand grain weight

Thousand grains were collected from individual treatments and electronic balance was used to record the weight of these grains.

Biological yield

During the mid of April, crop was harvested manually, untied into bundles and then left in the field for some days for sun drying in their respective treatment and then by using spring balance weight of whole biomass was recorded Ullah *et al.* (2018).

Grain yield

Small thresher was utilized for crop threshing, after threshing grain weight, the individual treatment was recorded with the help of spring balance and then it was expressed in tons per hectare ($t.ha^{-1}$).

Harvest index

The ratio of biological and grain yield generally termed as harvest index and it was recorded with the help of following formula..

HI= Grain yield/ Biological yield × 100

Grain protein content

In order to determine the protein contents in wheat kjeldhal method was applied that was followed by digestion, distillation and titration (Kjeldahl, 1883). It was implicated by digesting the grinded seeds with conc. Sulphuric acid and digestion fusion, which consisted of potassium sulphate, copper sulphate and iron sulphate at the ratio of 10:0.5:1 respectively. 30 mL conc. Sulphuric acid, 5 g digestion mixture along with 1 g oven dried powdered sample was placed in the kjeldhal digestion flask. The mixture was kept for almost 30 min and then mixture was heated at a slow flame in the initial state and then high flame up to the formation of opaque green shade liquid material. After that material, it was cooled and conveyed to a 250 mL volumetric

Table 1. Effect of Selenium and Moringa extract on germination, plant height and total tillers of wheat

S. No	Treatments	Time to 50 % emergence (days)	Time to start germination (days)	Mean emergence time (days)	Emergence index	Emergence count (m^2)	Plant height (cm)	Total tillers m^2
1	T_0	7.68^{a}	$6.00^{n.s}$	8.21^{a}	0.51^{b}	139.50^{a}	78.10^{d}	316.00^{d}
2	T_1	6.49^{b}	6.00	7.35^{b}	0.76^{a}	152.50^{a}	83.28^{a}	328.00^{cd}
3	T_2	6.86^{ab}	6.00	7.64^{ab}	0.62^{b}	161.00^{a}	81.92^{abc}	338.00^{bc}
4	T_3	-	-	-	-	-	82.06^{ab}	353.75^{a}
5	T_4	-	-	-	-	-	79.35^{bcd}	346.50^{ab}
6	T_5	-	-	-	-	-	79.16^{cd}	332.25^{bc}
7	**LSD (P 0.05)**	0.95	6.00	0.63	0.12	24.987	2.76	15.67

Table sharing the same case letter do not differ significantly at $p < 0.05$

$^{n.s}$ non-significant; T_0 = Control; T_1 = Osmo-priming with Se having 1.25 mM concentration; T_2 = Seed coating with Se (500 mg kg^{-1}); T_3 = Foliar application with Se (100 $g.ha^{-1}$); T_4 = Foliar application of *Moringa* extract at jointing; T_5 = Foliar application of *Moringa* extract at anthesis

flask. Then 5 mL liquid was taken in the micro kjeledhal apparatus by utilizing 10 mL of 40% conc. sodium hydroxide. 10 mL of having 4% concentration of boric acid were collected by ammonia vapours and bromocresol green and methyl red as an indicator was mixed in it. When the shade is converted from light pink shade to light green shade, the resulted distillate was again titrated adjacent to N/10 sulphuric acid and again the formation of methyl red (light pink) was reinstated. The quantity of elemental nitrogen was recorded by utilizing the formula.

$$N\ (\%) = \frac{A \times B \times C \times 0.0014 \times 100}{D}$$

where, A is the quantity of N/10 sulphuric acid utilized; B is the blank reading (N/ sulphuric acid used in blank reading); C is the volume made after digestion (250); D is the volume of digested sample used; 100 stands for percentage and 0.0014 is a factor which is the gram of nitrogen in mL (N/) Sulphuric acid

After that 'N' of treatment sample was multiplied by a general factor *i.e.* 6.25 to calculate the crude protein content in the wheat seeds.

Statistical analysis

The recorded data were investigated statistically by utilizing the Fisher analysis of variance technique (Steel *et al.,* 1997) and each treatment averaged values were related via Least Significance Difference (LSD) test at 5% probability degree.

RESULTS

Results specified that foliar application of Selenium (100 $g.ha^{-1}$) greatly influenced certain factors like total tiller per square meter, productive tillers per square meter, spike length, grain per spike, thousand grain weight, biological yield, grain yield, harvest index and grain protein contents in contrast to the rest of the treatments as shown in Table 1 and Table 2. Results indicated a significant difference with respect to time to 50% emergence of wheat that were coated or primed with selenium. Minimum 50% emergence time was taken by osmo-priming of selenium (6.49), that was statistically identical with seed coating with selenium having the mean value of (6.86).

Maximum 50% emergence time was taken at the control (7.68). Osmo-priming of selenium minimize the 50% emergence rate up to 15% and seed coating of selenium minimized 50% emergence rate up to 11% with respect to the control. Likewise, with respect to time to start germination, the results are non-significant having

Table 2. Effect of Selenium and Moringa extract on yield components and grain protein content (%) of

Treatments	Productive tiller (m^2)	Spike length (cm)	Spikelets per spike	Grain per spike	1000 grain weight (g)	B. Y (tons.ha^{-1})	G. Y (tons.ha^{-1})	S. Y (tons.ha^{-1})	H.I	Infertile tillers	GPC (%)
T_0	294.00^d	7.65^d	15.12^c	37.90^c	34.23^d	9.10^c	2.89^e	6.59^{ab}	31.87^{cd}	22.00^a	10.35^e
T_1	305.25^{cd}	8.20^c	16.40^a	44.68^a	35.20^{cd}	9.81^b	3.27^c	6.53^{ab}	33.25^{abc}	22.75^a	10.80^{de}
T_2	316.75^{bc}	8.50^{bc}	16.35^a	39.87^c	38.36^{ab}	10.16^{ab}	3.44^b	6.71^a	33.88^{ab}	21.25^a	11.63^{bc}
T_3	333.25^a	9.70^a	15.67^{bc}	45.23^a	40.56^a	10.47^a	3.62^a	6.70^a	34.64^a	20.50^a	12.48^a
T_4	323.25^{ab}	9.50^a	15.60^{bc}	41.25^b	39.63^{ab}	9.24^c	2.99^{de}	6.24^b	32.45^{bcd}	23.25^a	12.06^{ab}
T_5	311.25^{bc}	8.75^a	16.10^{ab}	44.56^a	36.96^{bc}	9.88^b	3.13^{cd}	6.75^a	31.70^d	21.00^a	11.17^{cd}
LSD (P 0.05)	15.445	0.45	0.611	2.16	2.70	0.56	0.15	0.46	1.30	3.81	0.69

Table sharing the same case letter do not differ significantly at p <0.05

$^{n.s.}$: non-significant; B.Y = Biological Yield; G.Y = Grain Yield; S.Y = Straw Yield; H.I = Harvest Index; GPC (%) = Grain Protein Content %; T_0 = Control; T_1 = Osmo-priming with Se having 1.25mM concentration; T_2 = Seed coating with Se (500 mg kg^{-1}); T_3 = Foliar application with Se (100 g ha^{-1}); T_4 = Foliar application of Moringa extract at jointing; T_5 = Foliar application of Moringa extract at anthesis

no specific difference in seed coating, hydropriming and control treatments. With respect to mean emergence time, results indicated that the significantly influenced output was seen in the mean emergence time for the germination of wheat, seeds were coated and primed with selenium. Minimum mean emergence time was recorded in 7.35, when osmo-priming of selenium of wheat was done that was statistically identical with seed coating of selenium 7.67. With respect to the control, 10% reduction in mean emergence time was recorded in osmo-priming with selenium.

Results also indicated that with respect to emergence index, maximum emergence index of wheat 0.76 was recorded when seeds of wheat were osmo-primed with selenium, followed by seed coating with selenium with the mean value of 0.62 that was statistically identical with the control (0.51). Likewise, with respect to final emergence count it was recorded in the seed coated with selenium with a mean value of 161 that was statistically in par with the osmo-priming of selenium at 152.5. Minimum final germination count was recorded in control with mean of 139.50. Plant height was maximum (83.28 cm) when osmo-priming of selenium having 1.25 mM concentration was applied, pursued by foliar application of selenium (82.06 cm), seed coating with selenium (81.92 cm), then followed by foliar application of Moringa at jointing (79.35 cm) that was statistically parallel with selenium seed coating, then pursed by Moringa extract application at anthesis.

Plant height was statistically non-significant with Moringa application at jointing was succeeded by control (78.10 cm) as revealed in Table 1. Breznik *et al.* (2005) also observed in his experiment that utilization of selenium as a seed priming greatly influenced the plant height of *Zea mays* L. Sajedi, (2010) stated that selenium application may improve the plant height, because selenium acts as antioxidant that play vital role to enhance the growth of cereals. Total tiller per square meter was found to be maximum (354) when selenium was utilized by foliar application, then pursued by Moringa extract application at jointing (346), then pursued by seed coating with selenium (338) that was statistically leveled with foliar application of Moringa at jointing (346) along with anthesis (332). Minimum total tillers per square meter were observed in control (316). The results were similar with experiment that was done in 1998, which observed that selenium utilization enhanced the number of tillers of wheat (Wu and Luo, 1998). Productive tillers were also maximum (333) when selenium was applied by foliar application, pursued by foliar application of Moringa extract at jointing (323),then followed by application of selenium by seed coating (317), that was statistically at par to foliar application of Moringa extract at anthesis (311) and jointing, which was pursued by osmo-priming of selenium (305); while minimum productive tillers were recorded in control treatment (294).

Number of tillers were improved by utilization of selenium in the field, which enhanced the growth in seedling of rice (Wu and Luo, 1998). Spike length was also maximum (9.70 cm) at foliar application of selenium which was then pursued by foliar application of Moringa at jointing (9.50 cm), followed by application of Moringa at anthesis (8.75 cm) that was statistically identical to foliar application of selenium and Moringa leaf extract at jointing, pursued by osmo-priming with Se at 1.25 mM (8.20 cm) that was statistically non-significant with seed coating of selenium. Spike length was minimum at control (7.65 cm). Nejat *et al.* (2009) also performed an experiment on maize *Zea mays* L. and observed that length of corn cob was improved by application of selenium in the field. Increase in pod length of various canola cultivars was recorded due to utilization of selenium in field (Zahedi *et al.,* 2009).

With respect to spikelets per spike, maximum spikelets per spike were observed when osmo-priming with selenium was done (16.40) that was statistically similar with seed coating with selenium (16.35), followed by Moringa application at anthesis (16.10). It was then followed by foliar application of selenium that was statically identical with foliar application of Moringa at jointing (15.60). Minimum spike-lets per spike were observed in control treatment (15.12). With respect to grains per spike, maximum grain quantity per spike were observed in foliar application of selenium (45.23) that was statistically parallel with osmo-priming of selenium (44.68), pursued by foliar application of Moringa at anthesis (44.56) and then pursued by foliar application of Moringa at jointing (41.25), which was succeeded by seed coating of selenium (39.87) and minimum grains per spike was observed in control (37.90) as shown in Table 2.

When 1000 grain weight was concerned, maximum 1000-grain weight was observed when foliar application of selenium @100 $g.ha^{-1}$ was applied (40.56 g) that was statically identical with foliar application of Moringa extract at jointing (39.63 g), seed coating with selenium (38.36 g), pursued by foliar application of Moringa extract at anthesis (36.96 g), then pursued by osmo-priming of selenium (35.30 g). While minimum 1000 grain weight was observed in control (34.23 g). The trail results are identical with conclusion of Nejat *et al.* (2009), who reported that utilization of selenium improved the 1000-grain weight of maize (*Zea mays*) L.

With references to biological yield, it was maximum (10.47 $tons.ha^{-1}$) recorded when foliar application of selenium @ 100 $g.ha^{-1}$ that was statically similar with seed coating of selenium (10.16 $t.ha^{-1}$), followed by foliar application of Moringa leaf extract at anthesis (9.88 $t.ha^{-1}$) that was statically identical with osmo-priming with selenium (9.81 $t.ha^{-1}$) and statistically at par by foliar application of Moringa leaf extracts at jointing (9.24 $t.ha^{-1}$). Least amount of biological yield was observed in control treatment (9.10 $t.ha^{-1}$). Likewise, maximum grain yield was observed (3.62 $t.ha^{-1}$) when foliar application of selenium @100 100 $g.ha^{-1}$ was done, that was followed by seed coating of selenium (3.44 t.ha^{-1}), which was followed by osmo-priming of selenium (3.27 t.ha^{-1}), that was statistically identical to the foliar application of Moringa at anthesis (3.13 t.ha^{-1}), and followed by foliar application of Moringa at jointing (2.99 t.ha^{-1}) that was statically identical with control. Minimum grain yield was observed at control (2.89 t.ha^{-1}). Higher 1000 grain weight, more grain per spike and more spike length are the key contributors of maximum grain yield in selenium when used by foliar application.

With respects to straw yield, maximum straw yield was observed in Moringa leaf extracts at anthesis (6.75 t.ha^{-1}) that was statistically identical with seed coating of selenium (6.71 t.ha^{-1}), foliar application of selenium (6.70 t.ha^{-1}), osmo-priming of selenium (6.53 t.ha^{-1}) and then control (6.59 t.ha^{-1}), which was pursued by foliar application of Moringa at jointing (6.24 t.ha^{-1}) that was statistically identical with foliar application of selenium, osmo-priming and control. Straw yield was minimum (6.24 t.ha^{-1}) when foliar application of Moringa at jointing stage was utilized. Growth and dry matter accumulation was greatly influenced in Indian mustard by utilization of selenium in field (Singh *et al.,* 1980).

With respect to harvest index maximum values was documented (34.64%) in plots that were treated with foliar application of selenium @100 g.ha^{-1} which was statistically identical with seed coating (33.88%), osmo-priming of selenium (33.35%) which was pursued by foliar application of Moringa extract at jointing stage (32.45%) that was statistically identical with osmo-priming of selenium (33.45%) and also along with seed coating with selenium, pursued by control (31.87%) that was statistically similar Moringa extract at anthesis stage. Harvest index of maize (*Zea mays* L.) was enhanced by utilization of selenium as a seed priming (Wanga *et al.,* 2003). As far as infertile tillers were considered minimum values (20.50) were observed in that plot where selenium was applied by foliar application, followed by seed coating of selenium (21.25), then followed by osmo-priming of selenium (22.75), which was followed by foliar application of Moringa extract at jointing stage. Greater number of infertile tillers was recorded (23.25) in plots where Moringa extract was utilized at jointing stage. The results are mentioned in Table 2.

With respect to grain protein content (%), maximum (12.48%) quantity of protein content was recorded in plots where foliar application of selenium was made that was statistically identical with foliar application of Moringa extract at jointing (12.06%), pursued by seed coating (11.63%) of selenium that was statistically non-significant with foliar application of Moringa extract at jointing stage, pursued by foliar application of Moringa extract at anthesis stage (11.17%) and was statistically non-significant with seed coating, pursued by osmo-priming of selenium (10.80%) which was statistically identical with foliar application of Moringa extracts at anthesis. Least amount (10.35%) of protein was recorded in control plots.

DISCUSSION

Selenium is a micro nutrient and its deficiency symptoms usually appears on newly leaves of plants (Drostkar *et al.,* 2016), who stated that the utilization of selenium by foliar application can significantly increase the 1000 grain weight, number of grain per spike and grain yield of wheat as compared to control treatment. Selenium generally acts as an anti-oxidant (Ekelund and Danilor, 2001) and that's why it involves in very diverse range of metabolic process in wheat especially in grain filling stage when drought stress occurs. Presence of selenium play vital contribution in grain yield of cereals crop as an antioxidant (Wanga *et al.,* 2003).

Minimum time was taken for germination in treatments either in the form of coating or as osmo-priming progression of the germination rate (Peng *et al.,* 1996). Scientists reported that seeds of the cereals when primed or coated with micronutrients, enhance the metabolic activity of seeds *i.e.* improve gibberellins concentration and minimized the 50% emergence time with respect to control (Rehman, 2012). Coating and priming of seeds minimize the lag phase of seeds and reduced the mean emergence time and emergence index of wheat with respect to non-primed wheat seeds due to delayed in metabolic activities initiation (Farooq *et al.,* 2005). Seed priming along with utilization of selenium promotes fast and swift germination of seed even for the bitter gourd which posses hard seed coat (Chen and Sung, 2001).

Maximum plant height was recorded when selenium was utilized by foliar application. Selenium application may improve the photosynthetic interception of light *i.e.* solar radiation activity along with massive improvement in vegetative growth character of plants which leads to better yield along with better grain size, 1000 grain weight, number of grain per spike and grain yield of wheat. In addition, selenium also helps in absorption of macro nutrient like calcium, magnesium and micro nutrients like iron, zinc, copper and manganese which also promotes better development of crop that leads to better yield in terms of grain (Longchamp *et al.,* 2016). Similarly, Moringa leaf extract also acta as an antioxidant (Njoku and Adikwu, 1997) and its application on jointing stage also improves 1000 grain weight, number of grain per spike, plant height and grain yield of wheat as compared to control treatment, but the previous stated agronomic parameters were far behind as compared to utilization of selenium along with foliar application.

Moringa leaf extract is enriched with zeatin along with cytokinin helps plant to maintain its green color and also improve the stress tolerance potential of plant (Peng *et al.,* 1996). It also plays vital role to improve the grain yield of plant. Despite having zeatin and cytokinin Moringa leaf extract is also enriched with 80% ethanol which fastens the growth of young plant. Moringa leaf extract also develops resistance to diseases and pest that leads to better yield at the time of harvesting (Makkar and Becker, 1996). Furthermore, it’s extract is also a rich source of nutrients like chromium, copper, manganese, magnesium, zinc, and phosphorous (Fuglie, 2000) and also vitamin B complex its help the plant to develop strong resistance against stressful environment (Thurber and Fahey, 2009). Similarly, foliar application of Moringa at the time of anthesis of wheat helps to decrease the infertile tillers of wheat due to presence of plant hormones that facilitate pollination and improve the protein content of wheat with respect to control.

Foliar application of Moringa leaf extract also enlarged the leaf area index, plant height, contents of chlorophyll a and b that leads to the improvement in the photosynthetic activity along with increase in root biomass which leads to provide maximum nutrients to plant and minimize the chances of lodging of wheat (Ali *et al.,* 2011). Minimum plant height, productive tillers, spike length, grain per spike, 1000 grain weight, biological yield, grain yield, straw yield, harvest index and grain protein content (%) was recorded in control, as the wheat crop was established under stressful environmental condition. That’s why control treatment doesn’t show better yield as compared to the rest of the treatment. So, the treatment like foliar application of selenium and Moringa leaf extract provide growth supporter compounds that contributes to positive the role in the yield of wheat under stressful environment (Ali *et al.,* 2011).

CONCLUSION

Mean germination time, time taken to 50% emergence and final emergence count of wheat was greatly influenced by application of selenium as seed coating and seed priming. The traits like plant height, 1000 grain weight, grain per spike, grain yield and harvest index and other corresponding parameters were demonically improved by foliar application of selenium @100 $g.ha^{-1}$. Despite utilization of selenium as foliar application not only had the ability to enhance growth but also not harmful for human body and health. Foliar application of selenium @ 100 $g.ha^{-1}$ enhanced the 1000 -grain weight along with biological yield, pursued by foliar application of Moringa extract at jointing stage of wheat while these traits were minimum in control. In short utilization of selenium as seed coating, seed priming or as foliar application in cropping system must be done in order to maximize the production of cereals like wheat, corn, rice, etc., in order to overcome the issue of food security.

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