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Germination and Seedling Growth of Soybean under the Impact of Seed Soaking with Fertigrain Start (Amino Acid Product) and Water

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The Laboratory experiment was performed at Seed Testing Laboratory, Department of Agronomy, Sindh Agriculture University, Tandojam during Spring 2016 to observe "germination and seedling growth of soybean under the impact of seed soaking with FertigrainStart (amino acid product) and water for different periods. The experiment was laid out in completely randomized design with three replications. The seed of soybean variety Rawal was used throughout the experiment. The treatments included untreated (Control),Fertigrain Start @ 2 ml kg^{-1} seed, Fertigrain Start @ 4 ml kg^{-1} seed, Water Soaking (1 hour),Water Soaking (2 hour),Fertigrain Start @ 2 ml kg^{-1} seed+Water Soaking (1 hour),Fertigrain Start @ 2 ml kg^{-1} seed+Water Soaking (2 hour),Fertigrain Start @ 4 ml kg^{-1} seed+Water Soaking (1 hour) and Fertigrain Start @ 4 ml kg^{-1} seed+Water Soaking (2 hour). The statistical analysis of data showed that germination and growth of soybean were significantly ($P<0.05$) affected by Fertigrain Start and water soaking. The results indicated that the maximum germination (%), root length, shoot length, leaves $seedling^{-1}$,root fresh weight and shoot fresh weight were observed in Fertigrain Start @ 4 ml kg^{-1} seed+Water Soaking (2 hour)followed by Fertigrain Start @ 4 ml kg^{-1} seed+Water Soaking (1hour), Fertigrain Start @ 2 ml kg^{-1} seed+ Water Soaking (2 hour) and Fertigrain Start @ 2 ml kg^{-1} seed+Water Soaking (1 hour) with non-significant ($P>0.05$) statistical differences. However, application of Water Soaking (2 hours), Fertigrain Start @ 2 ml kg^{-1} seed, Fertigrain Start @ 4 ml kg^{-1} seed and Water Soaking (1 hour) ranked 2nd, 3rd, 4th and 5th in almost all traits studied. However, minimum germination (%), root length, shoot length, leaves $seedling^{-1}$, root fresh weight and shoot fresh weight were noted under control. Hereafter, it is concluded from the results that application of Fertigrain Start @ 2ml kg^{-1} seed+Water soaking (1 hour) proved appropriate for obtaining optimum germination and subsequent growth of soybean.

Keywords: Soybean germination seedling growth seed soaking

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Introduction

Glycine max (L.) commonly known as soybean belongs to the legume family. Agriculture accounted for 20.9 percent of the Gross Domestic Product in 2014-15 and is a source of livelihood of 43.5% of the rural population. Increased agricultural production and great crops yield are essential for food security which makes the farming systems less vulnerable to climate change (GOP, 2015). During the year of 2013-14, 1.719m tons of edible oil of the value of Rs.148.633 bn ($1.245 bn) was imported. Overall availability of edible oil from all sourceswas estimated at 2.325m tons. Although, the government is laying more emphasis on the use of soybean as an oilseed as well as edible oil (Anonymous, 2014).

Many developing countries like Pakistan face serious deficiencies in protein and vegetable oil and must spend a considerable amount of foreign exchange on the import of vegetable oil in particular to meet local demand. Soybean has the potential to become the leading oilseed crop in the country. Increased domestic production would decrease Pakistan's dependence on costly imports, as well as having other benefits such as fulfilling the increasing demand for this oil by diet-conscious consumers and for soybean meal for the developing poultry industry and livestock sectors (MINFAL, 2011).

Soybean (*Glycine max* L.) is one of the most centraloilseed crops in the world. It comprises 18 to 22 percent oil and is highly desirable in the diet and has 40 to 42 percent ofhigh quality protein. Therefore, it is the best source of protein and oil and truly claims the title of the meat/oil that grows on plants. It is used in the food manufacturing for flour, cookies, biscuit, oil, vegetable cheese, margarine, candy, milk, lecithin and many other products. At contemporary, the United States of America has the major area under its cultivation. Soybean is also grown in other parts of the world including Peoples Republic of China, Brazil, Indonesia, Korea, Argentina and Japan. In Pakistan, soybean has suffered a setback and has, therefore, not been able to attain a respectable position among the oilseed crops. Its cultivation remained limited to a very small acreage and showed a declining trend (Anonymous, 2014).

Soybean has a immense potential as spring (Zaid Rabi) and autumn (Kharif) crop cultivation. Through the country cotton and rice 8.4 and 2.10 million hectares, respectively and 30% of this area leftovers fallow after each crop which could be brought under soybeancultivation. The results of past research publicized that soybeancouldgive rational yield in Sindh,Punjab, and high yield in the foothill areas of NWFP. Also, soybean also increases the soil status for ensuring crops of cotton and rice in the irrigated areas of Sindh and Punjab. Soybean is a very popular crop both in irrigated and rainfed areas without clashing any main crop like rice, cotton, and wheat. Therefore, the area which remains fallow can be utilized effectively (Anonymous, 2014).

Several physiological and biochemical changes take place in seeds during priming or as a consequence of osmotic conditioning. These includes increasevigor and overcoming of dormancy (Jie *et al.*, 2002), and these effects have been noted in soybean (Finch-Savage *et al.*, 2004) using PEG-6000. However, almost all of the work on osmopriming has been conducted under laboratory conditions, and few detailed researches have been reported on the performance of osmotically treated seed in the field (Khalil *et al.*, 2010).The overall purpose of seed priming is to hydrate the seed partially to a point where germination processes are started but not completed (Ashraf and Foolad, 2005).

Studies have proved that amino acids can directly or indirectly effectthe physiological biochemical and molecular activities of the plant. Amino acids are also applied to plant by integrating them into the soil. They help in improving the micro flora of the soil thereby facilitating the assimilation of nutrients (Alaei, 2011). Commercially available amino acid stimulants can increase fertilizer assimilation, increase uptake of mineral nutrients and water, enhance the photosynthetic rate and dry matter accumulation, and hence imporvecrop yield. Amino acids are well-known as bio-stimulant which have positive effects on plant growth, yield and significantly mitigates the injuries caused by a biotic stresses (Kowalczy and Zielony, 2008).

Fertigrain start (Amino acid) is extracted from vegetables and seaweeds. It contains amino acids and other natural nutrients which provide the nutrition and energy to seed thus increase seeds germination percentage and provide a vigorous start to plant.The fertigrain start has the excellent sticking ability to seed. After seed treatment with Fertigrain start, product covers the entire seed surface, and after germination of root from the seed product, it is immediately taken up by the plant. It provides the nutrition and energy to plant to emerge from the soil, improves root development (Anonymous, 2010).

Chemical fertilizers have degraded the fertility of the soil by making it acidic, rendering it unsuitable for raising crops (Faten *et al*., 2010). Seaweed fertilizer is a natural bioactive material, water soluble derived from marinemacroalgae found attached to the bottom in relatively shallow coastal water. It is a new generation of natural organic fertilizers containing highly effective, nutritious and promotes the faster generation of seeds and increase yield and the resistant ability of many crops. Seaweed fertilizer could be absorbed by plant within several hours after application and safe to human, animals, and environment. Seaweed manure besides increasing the soil fertility increases the moisture holding capacity and supplies adequate trace elements thereby improving the soil structure (Shehata *et al*., 2011). Different forms of seaweed have been reported to produce beneficial effects on cereals, pulses and flowering plants (Owen and Jones, 2001). Keeping in view the facts stated above a study was designed toexplorethe effect of seed soaking with a Fertigrain start on germination and growth of soybean seedling.

Materials and methods

The laboratory experiment was conducted at Seed Testing Laboratory, Department of Agronomy, Faculty of Crop Production, Sindh Agriculture University, Tandojam during spring 2016. The experiment was laid out in completely randomized design (CRD) with three replications. A 1.5 square ft plastic tray filled with soil dust was used for this study. The seed of soybean variety Rawal was used throughout the experiment. The source of amino acid was fertigrain start fertilizer, prepared by Jaffar brothers, Limited Pakistan. The experimental details are as under:

Treatments = 9

1. Control (untreated)
2. Fertigrain Start (F) @ 2 ml kg^{-1} seed
3. Fertigrain Start @ 4 ml kg^{-1} seed
4. Water Soaking (WS) (1 hour)
5. WS (2 hours)
6. F @ 2 ml kg^{-1} seed+WS (1 hour)
7. F @ 2 ml kg^{-1} seed+WS (2 hour)
8. F @ 4 ml kg^{-1} seed+WS (1 hour)
9. F @ 4 ml kg^{-1} seed+WS (2 hours)

Procedure for recording observations

1. Germination (%): The number of plants germinated was counted in all pots of each treatment and percentage was worked out.

2. Root length (cm): The root length was recorded from basal node to bottom of the plant in centimeters in each treatment and averaged.

3. Shoot length (cm): The shoot length was recorded from bottom to tip of the plant in centimeters in each treatment and averaged.

4. Leaves seedling^{-1}: Leaves of total seedlings emerged in each treatment were counted and divided by the total number of seedlings to get the leaves seedling^{-1}.

5. Root fresh weight (g): Fresh weight of total seedlings roots in each treatment was recorded in grams and divided by the total number of seedlings to get the root fresh weight seedling^{-1}.

6. Shoot fresh weight (g): Fresh weight of total seedlings shoots in each treatment was recorded in grams and divided by the total number of seedlings to get the shoot fresh weight seedling^{-1}.

Statistical analysis

The collected data was subjected to statistical analysis using Statistix-8.1 computer software (Statistix. 2006). The differences among the treatments means were compared by the LSD test, where necessary.

Result and Discussions:

Seed germination (%)

The data regarding germination (%) of soybean as affected by seed soaking periods in water and various level of Fertigrain start are given in Figure-1. Analysis of variance indicated that the effect of different levels of Fertigrain Start andwater soaking period was significant ($P < 0.05$) on germination (%).The results showed that maximum germination (96.6%) was observed in Fertigrain Start @ 4 ml kg^{-1} seed+Water soaking (2 hour),followed by each Fertigrain Start @ 4 ml kg^{-1} seed+Water Soaking (1 hour), Fertigrain Start @ 2 ml kg^{-1} seed+Water Soaking (2 hour) and Fertigrain Start @ 2 ml kg^{-1} seed+Water Soaking (1 hour) with 96.3, 96.0 and 95.6%, respectively. The application of Water Soaking (2 hours), Fertigrain Start @ 4 ml kg^{-1} seed, Fertigrain Start @ 2 ml kg^{-1} seed and Water soaking (1 hour), ranked 2nd, 3rd, 4th and 5thwith73.3, 69.3,68.0 and 64.0 % germination,respectively. However, minimum germination (56.0%) were recorded under Control (untreated) treatment.

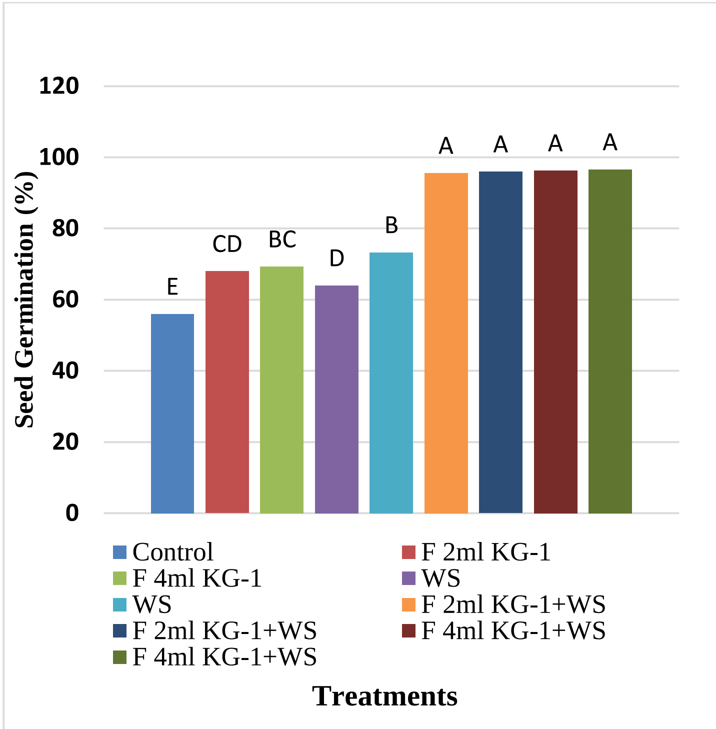

Figure 1. Seed germination

Root length (cm)

The data about root length (cm) of soybean as affected by seed soaking periods in water with Fertigrain start are given in figure-2. Analysis of variance presented that the effect of different levels of Fertigrain Start root length (cm) and the soaking period was significant ($P < 0.05$) on root length. The results illustrated that maximum root length (7.7 cm) was simultaneously recorded in Fertigrain Start @ 4 ml kg^{-1} seed+Water soaking (2 hours), Fertigrain Start @ 4 ml kg^{-1} seed+Water Soaking (1 hour), Fertigrain Start @ 2 ml kg^{-1} seed+Water Soaking (2 hour) and Fertigrain Start @ 2 ml kg^{-1} seed+Water Soaking (1 hour). The application of Fertigrain Start @ 4 ml kg^{-1} seed, Fertigrain Start @ 2 ml kg^{-1}seed,Water Soaking (2 hours), and Water soaking (1 hour) ranked 2nd, 3rd, 4th and 5th with 7.0, 6.7, 6.3 and 6.0 cm root length, respectively. However, minimum root length 4.7 cm was recorded under control (untreated) treatment.

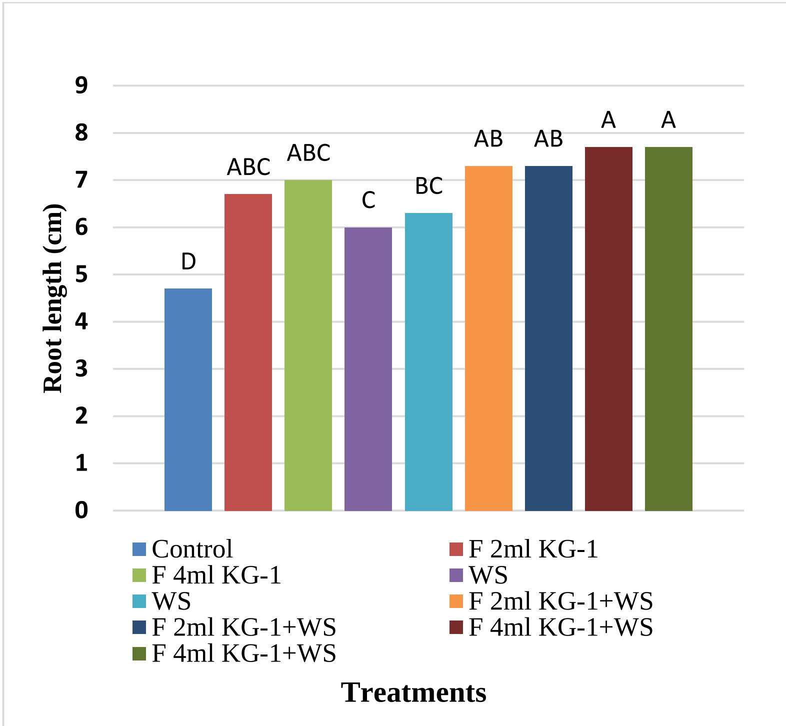

Fig. 2. Root length (cm)

Shoot length (cm)

The results for the shoot length (cm) of soybean as affected by seed soaking periods in water with Fertigrain start are given in figure-3. Analysis of variance showed that the effect of different levels of Fertigrain Start shoot length (cm) and the soaking period was significant ($P < 0.05$). The results showed that maximum shoot length 16.3 cm was observed in Fertigrain Start @ 4 ml kg^{-1} seed+Water soaking (2 hour), followed by each Fertigrain Start @ 4 ml kg^{-1} seed+Water Soaking (1 hour), Fertigrain Start @ 2 ml kg^{-1} seed+Water Soaking (2 hours) and Fertigrain Start @ 2 ml kg^{-1} seed+Water Soaking (1 hour) with 16.0, 15.7 and 15.3 cm, respectively having non-significant ($P>0.05$) differences with each other. The application of Fertigrain Start @ 4 ml kg^{-1} seed, Fertigrain Start @ 2 ml kg^{-1} seed, Water Soaking (2 hours) and Water soaking (1 hour), ranked 2nd, 3rd, 4th and 5th with 13.0, 12.0, 11.7 and 10.3 cmshootlengths, respectively. However, minimum shoot length 9.0cm was recorded under control (untreated) treatment.

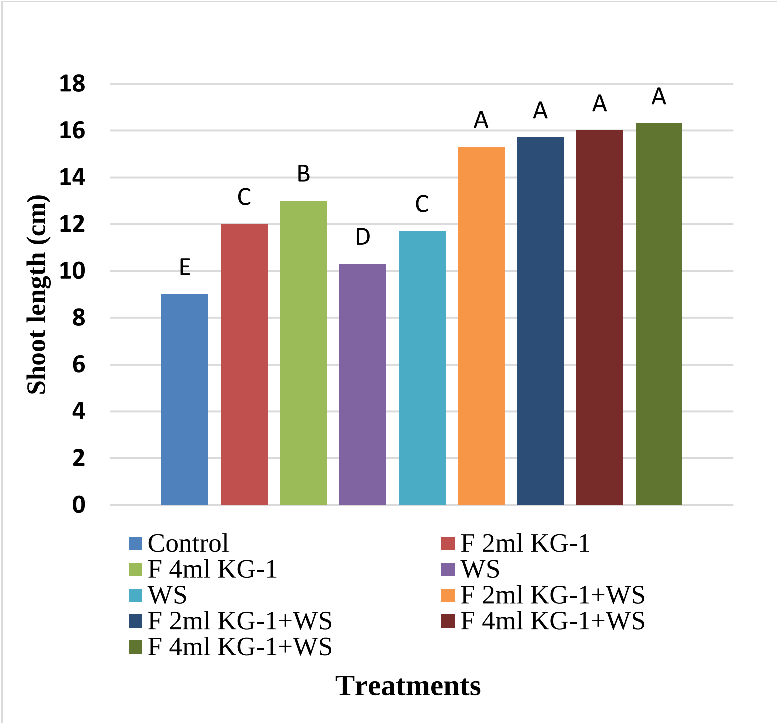

Fig.3. Shoot length (cm)

Leaves seedling^{-1}

The data indicate that the results of the leaves seedling^{-1}of soybean, as affected by seed soaking periods in water and various level of Fertigrain start,are given in figure-4. Analysis of variance showed that the effect of different levels of Fertig ran Start leaves seedling^{-1} and seed soaking period was significant (P <0.05). The results showed that maximum leaves seedling^{-1} 5.0 was observed in Fertigrain Start @ 4 ml kg^{-1} seed+ Water Soaking (2 hours) followed by each Fertigrain Start @ 4 ml kg^{-1} seed+Water Soaking (1 hour), Fertigrain Start @ 2 ml kg^{-1} seed+Water Soaking (2 hour) and Fertigrain Start @ 2 ml kg^{-1} seed+Water Soaking (1 hour) with 5.0, 4.7 and 4.7 respectively. The application of Fertigrain Start @ 4 ml kg^{-1} seed, Fertigrain Start @ 2 ml kg^{-1}seed, Water Soaking (2 hours) and Water soaking (1 hour), ranked 2nd, 3rd, 4th and 5th with 4.5, 4.0, 3.7 and 3.7 leaves seedling^{-1}, respectively. However, minimum leaves seedling^{-1} 3.7 were recorded under control (untreated) treatment.

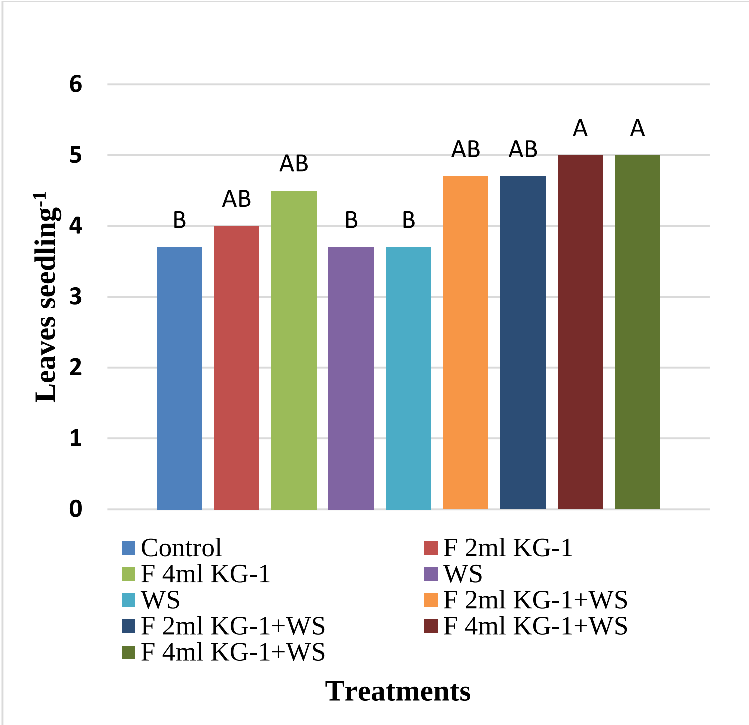

Fig.4. Leaves seedling^{-1}

Root fresh weight (g)

The data regarding fresh root weight (g) of soybean as affected by seed soaking periods in water and various level of Fertigrain start is given in figure-5. Analysis of variance showed that the effect of different levels of Fertigrain Start root fresh weight (g) and seed soaking period was significant ($P < 0.05$).The results showed that maximum root fresh weight 5.7 gwas observed in Fertigrain Start @ 4 ml kg^{-1} seed+Water soaking (2 hour) followed by each Fertigrain Start @ 4 ml kg^{-1} seed+Water Soaking (1 hour), Fertigrain Start @ 2 ml kg^{-1} seed+Water Soaking (2 hour) and Fertigrain Start @ 2 ml kg^{-1} seed+Water Soaking (1 hour) with 5.7, 5.3 and 5.3 g, respectively. The application of Fertigrain Start @ 4 ml kg^{-1} seed, Fertigrain Start @ 2 ml kg^{-1} seed, Water Soaking (2 hours) and Water soaking (1 hour), ranked 2nd, 3rd, 4th and 5th with 3.7, 3.7, 3.3 and 3.3 g root fresh weight, respectively. However, minimum root fresh weight 2.7 g were recorded under control (untreated) treatment.

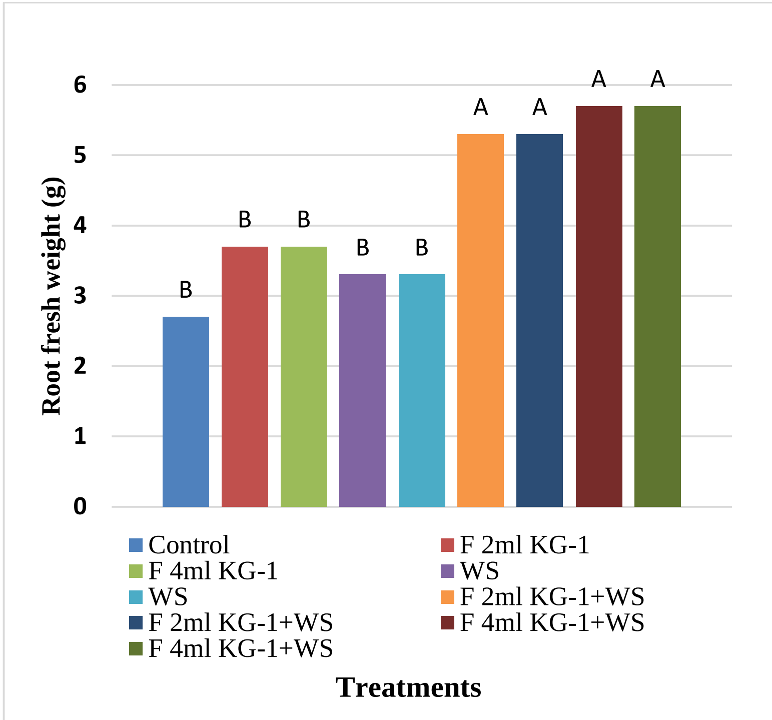

Fig.5. Root fresh weight (g)

Shoot fresh weight (g)

The data about shoot fresh weight (g) of soybean as affected by seed soaking periods in water and various level of Fertigrain start is given in figure-6. Analysis of variance showed that the effect of different levels of Fertigrain Start shoot fresh weight (g) and the soaking period was significant ($P < 0.05$). The results showed that maximum shoot fresh weight 23.0 g was observed in Fertigrain Start @ 4 ml kg-1 seed+Water soaking (2 hour)followed by each Fertigrain Start @ 4 ml kg-1 seed+Water Soaking (1 hour), Fertigrain Start @ 2 ml kg-1 seed+Water Soaking (2 hour) and Fertigrain Start @ 2 ml kg^{-1} seed+Water Soaking (1 hour) with 23.0 , 23.0 and 22.0 g , respectively. The application of Fertigrain Start @ 4 ml kg^{-1} seed, Fertigrain Start @ 2 ml kg^{-1} seed, Water Soaking (2 hours) and Water soaking (1 hour), ranked 2nd, 3rd, 4th and 5th with 17.7, 17.0, 13.0 and 12.3 g shoot fresh weight, respectively. However, minimum shoot fresh weight 11.0 g were recorded under control (untreated) treatment.

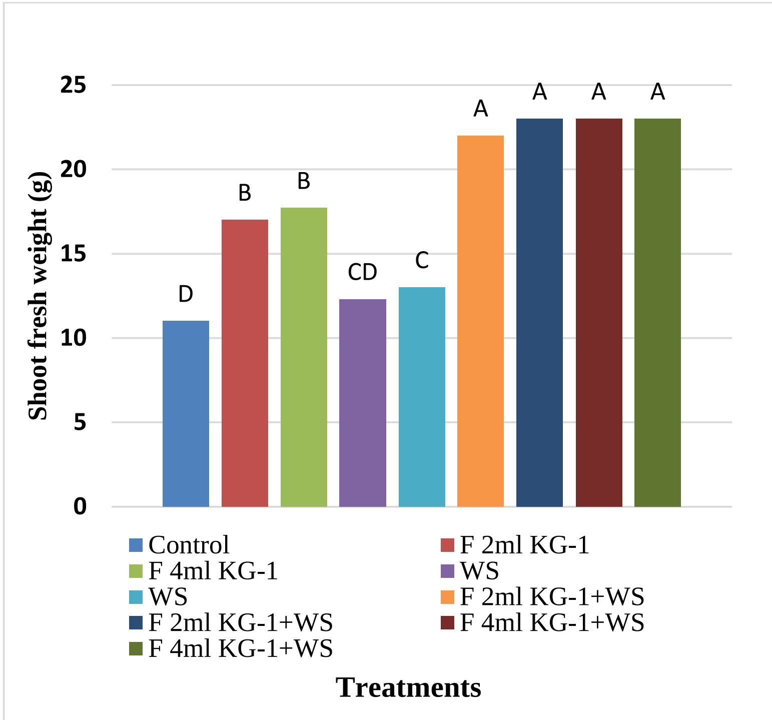

Fig.6. Shoot fresh weight (g)

Discussion

The investigation on the effect of various seed soaking methods with fertigrain start (amino acid product) on seedling growth of soybean under controlled condition showed that different seed soaking methods influenced the growth of seedling of soybean. While the increase in the dose of fertigrain start (amino acid product) methods showed significant results,indicates that fertigrain start (amino acid product) is efficient and beneficial for the growth of seedling of soybean. Commercially available amino acid stimulants can increasefertilizer assimilation, enhance uptake of mineral nutrients and water, enhance the photosynthetic rate and dry matter accumulation, and hence increase crop productivity. Amino acids are well-known as bio-stimulant which have positive effects on plant growth, yield and significantly mitigates the injuries caused bybiotic stress (Kowalczy and Zielony, 2008). The fertigrain start extracted from vegetables and seaweed. It has amino acids and other natural nutrients that provide nutrients and energy to the seed, thereby increasing the seed germination rate and providing a strong start to start planting. Fertigrain began to have excellent adhesion. After treatment with the

Fertigrain start seed, the product covers the entire seed surface and immediately after the germination of the root from the seed product, it is immediately absorbed by the plant. It provides plants with nutrients and energy, unearths from the soil, and improves root development (Anonymous, 2010)

Rapid and uniform field emergence is an important pre-requisite to reach the yield potential, quality and ultimately profit in annual crops (Butler *et al*., 2009). To achieve better quality and better yield leading to better profitability use of fertilizer and pesticides is not adequate. Now is the time to look at Bioenergetics and Biochemical aspects of plants. Among plant growth promoters, the amino acids are bio-organic derivatives which are obtained from biological sources like fish waste, animal waste (slaughterhouse waste), seaweeds,etc. (Fawzy *et al*., 2012). Fertigrain start (Amino acid) extracted from vegetables and seaweeds. It contains amino acids and other natural nutrients which provide the nutrition and energy to seed thus increase seeds germination percentage and provide a vigorous start to plant.Given facts stated above, the present study was carried out to evaluate the impact of bio-organic amino acid fertilizer (fertigrain start) on emergence, growth, and development of wheat seedlings under lab conditions at Tandojam.

These results are in concurrence with those ofAl-Majathoub (2003) who reported that application of commercially available organic growth stimulants (biostimulants) at some specific stages of wheat (*Triticum aestivum* L.) growth resulted in enhanced crop yields and quality. Improvement of plant growth and increases in yieldobserved for all biostimulants, but Vigro showed significant yield increases. The plants treated with Vigro exhibited an increase in the total tiller number of 21%, a greater number of fertile florets per spike. Nevertheless, the economic yield (grain yield) had improved by 8.2%. Similarly, Abdel-Mawgoud *et al*. (2011) found that the highest concentration of Manni-Plex (a sugar alcohol formulation containing) and the lowest concentration of Amino-green (a mixture of amino acids and micronutrients) improved growth parameters i.e. plant height, the number of leaves and fresh and dry weights of green bean. The results are also in line with those of Matysiak *et al*. (2011) who showed that in glasshouse and laboratory experiments seaweed extracts strongly induced seed germination than humic substances. Joint seed and foliar application and second foliar application promoted shoot and root growth of maize. Moreover, Ramya *et al*. (2011) disclosed that found to have maximum influence on growth parameters viz., shoot length, root length, fresh weight, dry weight, leaf area and moisture content cluster plant.

The results of present experiment clearly suggested that Fertigrain Start positively and significantly affected emergence and growth of wheat variety Kiran-95. However, Fertigrain Start @ 2ml kg^{-1} seed was found as the optimum dose which resulted in numerically lower but non-significant values as compared to Fertigrain Start @ 2ml kg^{-1} seed. The results of the present study suggested that seed treatment with Fertigrain Start affected germination and seedling growth of soybean variety Rawal positively and significantly ($P<0.05$).Fertigrain Start @ 4 ml kg^{-1} seed+Water Soaking (2 hour) thatthe maximum germination 96.6%, root length 7.7 cm, shoot length 37.7 cm, leaves $seedling^{-1}$5.0 ,root fresh weight 5.7 g and shoot fresh weight 23.0 g followed by germination 96.3 %, root length 7.7 cm, shoot length (36.7 cm), leaves $seedling^{-1}$ (5.0), root fresh weight 5.7 g and shoot fresh weight 23.0 g was observed in Fertigrain Start @ 4 ml kg^{-1} seed+Water Soaking (1 hour) water. However, application of Fertigrain Start @ 2 ml kg^{-1} seed, Fertigrain Start @ 4 ml kg^{-1} seed , water soaking (1 hour), water soaking (2 hour) , Fertigrain Start @ 2 ml kg^{-1} seed+Water Soaking (1 hour) Fertigrain Start @ 2 ml kg^{-1} seed+ Water Soaking (2 hour) were ranked 2nd , 3rd , 4th, and 5th in almost all traits studied. While minimumgermination 56.0 %, root length 4.7 cm,shoot length 23.7 cm, leaves $seedling^{-1}$ 3.7root current weight 2.7 g and shoot fresh weight 11.0 g under control were noted. These results are in harmony with those ofAl-Majathoub (2003) who reported that application of commercially available organic growth stimulants (biostimulants) at some specific stages of wheat (*Triticum aestivum* L.) growth resulted in enhanced crop yields and quality. Enhancement of plant growth and increases in yield were perceived for all bio-stimulants, but Vigro showed important yield increases. The plants treated with Vigro demonstrated an increase in the total tiller number of 21%, a greater number of fertile florets per spike. However, the economic yield (grain yield) had improved by 8.2%. Similarly, Abdel-Mawgoud *et al*. (2011) found that the highest concentration of Manni-Plex (a sugar alcohol formulation containing) and the lowest concentration of Amino-green (a mixture of amino acids and micronutrients) improved growth parameters i.e. plant height, the number of leaves and fresh and dry weights of green bean. The results are also in line with those of Matysiak *et al*. (2011) who showed that in glasshouse and laboratory experiments seaweed extracts strongly induced seed germination than humic substances. Joint seed and foliar application and second foliar application promoted shoot and root growth of maize. Moreover, Ramya *et al*. (2011) disclosed that found to have maximum influence on growth parameters viz., shoot length, root length, fresh weight, dry weight, leaf area and moisture content cluster plant. Abdel-Mawgoud *et al*. (2011) investigated the effectiveness of using micronutrients or amino acids mixed with some micronutrients to increase growth and production of green bean (*Phaseolus vulgaris*, L.) cv. Pulista.

Green bean grown plants was sprayed twice at three and six weeks from sowing with Manni-Plex, a sugar alcohol formulation having (0.2% B, 0.3% Iron, 3.2% Mn, 2% Zn and 5% N) or Amino-green, a mixture of amino acids and micronutrients (15% amino acids, 2.9% Fe, 1.4% Zn and 0.7% Mn) in concentrations of 1.0 and 2.0 cm^3 L^{-1} for the two compounds. Data showed that the highest concentration of Manni-Plex and the lowest concentration of Amino-green improved growth parameters i.e. plant height, the number of leaves and fresh and dry weights Meanwhilesome branches werenot significantly affected. Pod yield was positively associated with the applied concentration of the two substances with the highest effect recorded with 2 cm^3 L^{-1}Manni-Plex. Pod quality predominantly protein contents responded more positively to the Amino-green application while fiber contents responded negatively to all applied treatments.

Conclusion

The results concluded that effect of water soaking and Fertigrain Start application was significant ($P<0.05$) on germination and seedling growth of soybean. However, application of Fertigrain start @ 2 ml kg^{-1} seed+Water soaking (1 hour) was found appropriate for obtaining optimum germination and subsequent growth of soybean seedlings.

References

Abdel-Mawgoud, A. M. R., A. M. El-Bassioun, A. Ghoname, and S. D. Abou-Hussein (2011). Foliar application of amino acids and micronutrients enhance theperformance of green bean crop under newly reclaimed land conditions. Aust. J. Basic Appl. Sci., 5(6): 51-55.

Alaei, Y. (2011).The effect of amino acids on leaf chlorophyll content in bread wheat genotypes under drought stress conditions. Middle-East J. Sci. Res., 10 (1): 99-101.

Al-Majathoub, M. (2003). Effect of biostimulants on the production of wheat (*Triticum aestivum* L.). Plant Science, 164: 317-322.

Anonymous. (2010). Agriculture. Agro Chemicals. Jaffer Group of Companies. http://www.jaffer.com/BusinessUnits/JAS_Agro_Fertigrain

Anonymous. (2014). Cultivation of soybean in Pakistan during the year 2013-14, www.Pakissan.com

Ashraf, M. and M.R. Foolad. (2005). Pre-sowing seed treatment a shotgun approach to improving germination, plant growth, and crop yield under saline and non-saline conditions. Adv. Agron., 88:223-271.

Butler, L.H., F.R. R.H. Hay, R.D.E. Smith and T.B. Murray. (2009). Priming and re-dryingimprove the survival of mature seeds of *Digitalis purpurea* during storage, Ann. Bot., 103:1261-1270.

Faten, S., Abd El-Aal., A. M. Shaheen, A. A. Ahmed and A. R. Mahmoud. (2010). Effect of foliar application of urea and amino acids mixtures as antioxidants on the growth and yield and characteristics of squash. Res. J. Agri. Biol. Sci., 6 (5): 583-588.

Fawzy, Z.F., Z.S., El-Shal, L. Yunsheng, O. Zhu and O. M. Sawan. (2012). Response of garlic (*Allium sativum* L.) plants to foliar spraying of some bio-stimulants under sandy soil condition. J.Appli.Sci., Res., 8 (2): 770-776.

Finch-Savage, W.E., K.C. Dent and L.J. Clark. (2004). Soak conditions and temperature following sowing influence the response of maize (*Zea mays* L.) seeds toconfirm priming (pre-sowing seed soak). Field Crops Res., 90: 361-374.

GOP, (2015). Economic Survey of Pakistan 2014-2015. Government of Pakistan, Ministry of Food, Agriculture, and Livestock, Agriculture & Livestock Division (Economic Wing), Islamabad.

Jie, L., L.G. She, O.D. Mei, L.F. Fang and W.E. Hua. (2002). Effect of PEG on germination and active oxygen metabolism in wildrye (*Leymusch inensis*) seeds. Act. Pratacult. Sin., 11: 59–64.

Khalil, S.K., S. Khan, A. Rahman, A.Z. Khan, I.H. Khalil, Amanullah, S. Wahab, F. Mohammad, S. Nigar, M. Zubair, S. Parveen and A. Khan. (2010). Seed priming and phosphorus application enhance phenology and dry matter production of wheat. Pak. J. Bot., 42: 1849–1856.

Kowalczy, K. and T. Zielony. (2008). Effect of aminoplant and asahi on yield and quality of lettuce grown on rockwool. Conf.ofbio-stimulators in modern agriculture, 7-8 Febuary 2008, Warsaw, Poland.

Matysiak, K., S. Kaczmarek and R. Krawczyk. (2011). Influence of seaweed extracts and mixture of humic and fulvic acids on germination and growth of *Zea mays* L. Acta Sci. Pol., Agricultura, 10 (1): 33-45.

MINFAL, (2010-2011). Ministry of Food, Agriculture, and Livestock. Agricultural Statistics of Pakistan. Government of Pakistan, Islamabad

Owen, A. G., and D.L. Jones. (2001). Competition for amino acids between wheat roots and rhizosphere microorganisms and the role of amino acids in plant N acquisition. Soil Biol. Biochem., 33: 651–657.

Ramya, S.S., S. Nagaraj and N. Vijayanand. (2011). Influence of seaweed liquid extracts on growth, biochemical and yield characteristics of *Cyamopsis tetragonolaba*(L.). J. Phytol., 3 (9): 37-41.

Shehata, S.M., S. Heba, Abdel- Azem, A. Abou El-Yazied and A.M. El- Gizawy. (2011). Effect of foliar spraying with amino acids and seaweed extract on growth, chemical constitutes, yield and its quality of Celeriac plant. European Journal of Sci. Res., 58(2): 257-265.

Statistix. (2006). Statistix 8 user guide, version 1.0. Analytical Software, PO Box 12185, Tallahassee FL 32317 USA. Copyright © 2006 by Analytical Software.

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