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Effect of different fertilizers on seed germination and seedling growth of sunflower (*Helianthus annuus* L.) from district Bhimber of Azad Jammu and Kashmir, Pakistan

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Abstract
In this research, impact of different fertilizers on seed germination and seed growth of Sunflower (*Helianthus annuus* L.) was determined in year 2012. In the study, different doses of DAP, Urea and farm yard manure (FYM) were employed on experimental trials conducting in Randomized Complete Block Design (RCBD) in campus experiment grids. Highest germination rate was determined for Urea (87.5%) and followed by FYM (85%). For growth parameters Urea depicted maximum rate of shoot length (34.62 ± 0.15) at 30 days and for manure it's was 31.70 ± 0.22. After 30 days, root length was 12.88 ± 0.23 and 16.10 ± 0.43 after 60 days. Number of leaves were Urea 10.37 ± 0.37 and in DAP number of leaves were 8.50 ± 0.54. In plant samples, fresh weight (FW) of was highest 18.0 ± 0.21 at 30 days and 60 days its FW was 27.67* ± 0.29. Dry weight (DW) of leaves was highest (4.03 ± 0.07) and least in control sample (3.10 ± 0.09). FW of roots was found highest in Urea and followed by FYM (43.00 ± 0.86), while DW of roots was maximum in Urea fed sample (10.80 ± 0.23). These results depicted that urea is best fertilizer for germination of seedlings of sunflower and second one is FYM fertilizer. The vegetative growth (shoot, root and leave length) was highest in experimental plots of in urea fertilizer. This research presents that different combinations of fertilizers may produce better results and further research is required.

Keywords: sunflower, bhimber, farmyard manure, fertilizers, RCBD

Introduction

Sunflower (*Helianthus annuus* L.) over the years has emerged as an important ornamental and oilseed crop in the world. It is a successful crop both in irrigated and in rain fed areas and grow well, when planted in areas with adequate sunlight, light–textured and well drained sandy loam soil. World area under sunflower cultivation is 22.3 million hectares, with seed production 27.7 million tons (Adebayo *et al*., 2012) [12]. The assembly of sunflower seeds in the world increased from 26 to 31 million metric tons between 2004 and 2006 (FAO, 2007) [5], whereas total production of sunflower oil in world was 10 million metric tons from 2005 to 2007, being overtaken only by soybean, canola and palm (USDA, 2007) [15]. During 2009-10, the area under Sunflower crop in Pakistan was 872 thousand acres with seed and oil production of 554 and 211 thousand tons, respectively (GOP, 2010) [6]. Pakistan has been facing severe shortage of edible oil for last so many years. It is producing about one third of its edible oil necessities and the rest is met through import at a cost of about Rs. 60 billion per annum (MINFAL, 2008) [9]. As Pakistan is a developing country, more than 67% its total population is living in rural areas and their earning are mainly depends on agriculture (Bhutto *et al*., 2007) [3]. Recently it is considered as bio diesel plant (Pereyra-Irujo *et al*., 2009) [11]. It is a God gifted plant for humankind. It plays a dynamic role with multiple characteristics in human life. Sun flower has much importance which attracts the researcher to study it. It is considered as highly economic plant, because oil is obtained from its seeds which are exported to increase the economics of the country.

About 35% of the total oil requirements are met from domestic assembly and 65% from imports. The cotton seeds plying key role in the home resources of edible oil, contributing 67% of domestic production. Canola is after cotton seeds which contribute about 19.6% while rest of 13.4% is contributed chiefly by sunflower. The total area under cultivation in Pakistan is 20.69 million ha. Out of this area 16.48 million ha or 79.65% is irrigated. In 1970- 71 oilseeds occupied about 3% of the total cultivated area but it is decreased to 2.5 % by 2002-03 due to a low oil seeds production. The edible oil necessities are compensating through imports. As a result the imports bill rose from Rs. 77 million in 1969-70 to Rs. 3900 million in 2002-03 over burdening the economy of country (Shah *et al*., 2005) [13]. Sun flower contains 40-50% edible oil and 15-21% protein. In the last few years, sunflower oil has also occupied special recognition based on non-food purposes. It is feasible as bio-diesel or as vegetable-based fuel for many vehicles or instruments including farming equipments (Pereyra-Irujo *et al*., 2009) [11].

The sunflower plant has a hairy stem, wide and thickly toothed rough leaves and rounded heads of flowers. The heads comprises of numerous individual flowers which mature later into seeds, often in the hundreds on a vessel like bottom. The substantiation thus far is that the sunflower was primary domesticated in what is now the southeastern United State approximately 5000 years ago and perhaps introduced into Mexico at an early on date as supplementary crops such as maize were exchanged. The most primitive acknowledged examples of entirely domesticated sunflower have been grouped in Tennessee around 2300 BC. Many native people of United Sates used the sunflower as the figure of their astral idol together with Aztecs and the Otomi of Mexico and the Incas in South America. In early 1510 Spanish explorers

encountered the *Helianthus anus* in the Americas and carried its seeds back to Europe (Putt, 1997) [12].

In an assessment found that in 100g of Sun flower seeds contain 560 calories (energy), 24.0g protein, 4.8g H_2O, 47.3g fat, 3.8g fiber, 4.0g ash, 19.4g total carbohydrate, 120mgCa, 837mgP, 7.1mgFe, 30mgNa, 920mgK, 30mg carotene equivalent, 1.96mg thiamine, 0.23mg riboflavin, 5.4mg niacin and 0 mg ascorbic acid. As for as, the matter of seed is concern, it contains about 25–35% of oil. On the behalf of chemical analysis of oil, about 44–72% linoleic acid and 13–20% protein of high natural value and digestibility is found. Stems and husks are loaded with potash. Flowers have 12.7% protein, 13.7% fat, 64.3% carbohydrate, 32.9g fiber, 9.3g ash, 630mg Ca, and 80mg P in 100g. Sunflower oil has a rich level of linoleic acid, intermediate level of oleic acid and very low level of linolenic acid (Dorrell, 1981) [4].

Fertilizer is an organic or inorganic material of biological or artificial (man-made) source (other than liming material) which is given to a soil to supply nutrients essential for growth in plants (SSSA, 2011). A fresh consideration found that about 40% - 60% of crop yield is attributable to commercial use of fertilizer. The market value of European/western fertilizer is estimated to grow up to €15.30 billion in 2018. Mined in-organic fertilizers have been used for numerous centuries; whereas the Chemically Synthesized In-organic Fertilizer (CSIF) was extensively developed only during the industrial revolt. The usage of fertilizers was significant practice in the pre-industrial British Agricultural Revolution (BAR) and the industrial Green Revolution (GR) of 20th century (Stewart, 2005). Fertilizers are typically provided in different proportions. Plants need macro nutrients such as Nitrogen (N), Phosphorus (P), Potassium (K), Calcium (Ca), Magnesium (Mg) and Sulphar (S). Similarly Seven micro nutrients like Boron (B), Chlorine (Cl), Copper (Cu), Iron (Fe), Manganese (Mn), Molybdenum (Mo) and Zinc (Zn) are essential for plant growth.

The macronutrients are addicted in bigger quantities and are present in plant tissue from 0.15% - 6.0% on a dry matter (moisture) basis (DM) while micronutrients are addicted in smaller quantities and are present in plant tissue on the order of parts per million (ppm) ranging from 0.15 to 400 (ppm) DM or less than 0.04% DM. The nitrogen rich fertilizer NH_4NO_3 is used also as an oxidizing agent in improvised unstable devices, sometimes known as fertilizer bomb (Mills, 1996). If the plants are present in dissolved chemical compounds then they can absorb their required nutrients easily. China, USA, France, Germany, Brazil, Canada, Turkey, UK, Mexico, Spain and Argentina are advance user of fertilizer, respectively (UNFAO, 2009).

Fertilizers are broadly divided into two types such as organic fertilizers which is composed of organic plant or animal matter. It includes naturally occurring materials e.g. chicken litter, manure, worm castings, compost, seaweed, guano, bone meal or biologically occurring mineral deposits saltpeter etc, while inorganic fertilizer is manufactured in market and also known as chemically synthesized, artificial or commercial fertilizer (Karin *et al*., 2005) [7].

The under vision of research was to conduct study on "effect of different fertilizer i.e. Urea, Manure and DAP on seed germination and seedling growth of Sun flower and to find out that which fertilizer is supporting its growth rate". The key purpose of this research is to improve the production of "Sun flower in order to improve the economy of country".

Materials and methods

Experimental site

Experimental field was selected in experimental land of Deptt of Botany, MUST Bhimber Campus in District Bhimber of Azad Kashmir. Study was conducted to observe the effect of different fertilizer on seed germination and seedling growth of Sunflower during August to October, 2012.

Soil Analysis

The soil analysis was done before sowing the seeds from Soil Testing Laboratory of Agriculture Department in Bhimber and soil constituents of study area were calculated.

Seed Collection and Experimental Design

The process of seed collection was completed with suitable arrangements of seeds from the Department of Agriculture in Bhimber. Healthy types of seed were selected for experimental work. The experiment is done in Randomized Complete Block Design (RCBD). This design is suitable and easy to obtaining the data from field and more better to study the effects of treatment in physiology. Plots were irrigated according to the requirement of water. Weed management was undertaken once in a week.

Fertilizer Application

Three different types of fertilizers were given to observe the effect on seed germination and seedling growth of Sun flower. Fertilizers were mixed with soil and applied in each plot equally in quantity. The Types of fertilizer used were as:

1. Animal Manure (Organic) 500g
2. Urea (Organic) 500g
3. DAP (Inorganic) 500g

Four replicates were used for each treatment. All these fertilizers were applied at the time when seeds were sown.

Effect of Fertilizer on Seed Germination

In order to find the effect of fertilizer on seed germination, the timings of seed germination in experimental plots were observed carefully. After collection the data, it was further analyzed statistically to determine the % of seed germination.

Effect of Fertilizer on Seedling Growth

In order to find the effect of fertilizers on seedlings growth the measurement of length and weight of different plant parts were recorded carefully. The dry and wet weight of leave and root were recorded with help of electrical balance while the length of shoot and root were recorded with the help of centimeter scale. All the data were tabulated for further analysis.

Statistical analysis

The data from each experimental field were subjected to appropriate statistical analysis. The one way analysis of variance (ANOVA) at 5% level of significance was done as a procedure given by Fisher Yates in 1963.

LSD test was used to compute the smallest difference between the means of all values at 5% level of significance by following formula,

$$LSD = t_{\alpha/2(\upsilon)} \sqrt{\frac{2s^2}{r}}$$

Two plants from each replicates and over all eight plants from each treatment were selected randomly. Then mean values were taken and the final values were recorded as mean ±standard error mean.

Results and Discussion

Study was conducted at in Department of Botany, MUST, Bhimber Campus in district Bhimber of Azad Kashmir during cropping season August-to-October 2012. This experiment was undertaken to find the effect of application of different fertilizers on seed germination and seedling growth of *Helianthus annuus* L. The experimental field was situated at a place where sun continually shined without any side disturbance. The environmental condition remained suitable for the field during research. The soil analysis was done in Soil Testing Laboratory of Agriculture Department in Bhimber before sowing. According to analysis the soil of the area is loam and heavy loam. pH ranges from 6.2 to 6.6 %, organic matter ranges from 1.9 to 2.15 %, percentages of phosphorus ranges from 10 to 16 %, potash ranges from 160 to 200 % and saturation capacity of soil is 42 to 45 %.

Seeds were collected from the Department of Agriculture in Bhimber. A healthy type and the best available quality of seed were selected for experimental work. A kind of Sunflower Hysen-33 was used in experiment. Experimental field was cleared and ploughed to make soft seedbeds. It was in Randomized Complete Block Design which was 160 inches (400cm) in length and 100 inches (250cm) in width (160×100). The field was consist of 16 plots arrangement, each with 40 inches long and 25 inches width (40×25). Seeds were in the depth of 1-1.5 cm in soil. Plots were irrigated according to the requirement of water. Weed management was undertaken once in a week.

In order to observe the typical role of fertilizer in the seed germination and seedling growth of sun flower, application of three different types of fertilizers were given in a proper manner. Its application showed a significant improvement in different plant parts. Plant depends upon nutrients available in soil for their proper growth. The depletion of nutrients badly effects upon productivity of plants. Fertilizers provide these nutrients. The source of these nutrients is either organic or inorganic. In this under vision research both organic and inorganic fertilizer were used. The Types of fertilizer used were

i) Animal Manure (Organic) 500g
ii) Urea (Organic) 500g
iii) DAP (Inorganic) 500g

Four replicates were used for each treatment. The quantity of fertilizers which was given to each sub-plot was 125 g. Twelve (12) plots were treated with three different kinds of fertilizers, while remaining four sub-plots were kept as control group. The fertilizer was given with completely randomized manner. All these fertilizers were applied at the time when seeds were sown. The use of fertilizers in soil positively affected the seed germination process**.** It is noted that with all type of fertilizers the percentage (%) of germination enhanced as compared to control. 40 seed were sown in each treatment. Urea was more significant when compared with other two fertilizers. After Urea, Manure showed maximum germination. DAP was at number 3rd among fertilizers used in field experiment. The timing of seed germination in experimental plots was observed carefully. The total number of seed germinated and their possible percentage is given in Table 1.

The fertilizer amendments significantly affect the seedling growth. It was observed that fertilizer increased the different plants parts but organic fertilizers showed the best results as compared to inorganic fertilizers. The different plant parts were measured with suitable measuring instruments in order to find out the effect of different fertilizer amendments. The shoot length was measured with the help of centimeter scale after 30 and 60 days. The level of significance is 0.05. The LSD value is different in both 30 and 60 days readings. Error degree of freedom is 12 while error mean square is 0.373 and 1.89, respectively (Table 2).

The present study is conducted to determine that which type of fertilizer can be more efficiently used for the sunflower crop. After careful experiments, different results are found with different treatments. As shown in Table 1, the maximum germination is noted in Urea fertilization application plot trial. As mentioned earlier that total 40 plant seeds were sown in each treatments and from those forty plants 35 plant seedlings oozed out in urea. After urea, 34 plant seedlings were germinated in manure while 31 seedlings were grown in DAP and 29 plants germinated in control group. Similarly, some variations and fluctuations were found in their time of germination. The seeds treated with urea germinated after 10 days while those treated with manure after 12 days. But there is no differences in the timing of seed germination between DAP and control group. Seeds germinated after 14 days in both these groups. It was further conformed that the fertilizer is not only significant in seed germination but also in seedlings growth and development. To get more accurate findings, the measurements of physical parameters of seedlings and plants were taken twice after 30 and 60 days. LSD is calculated and taken as standard value to compare the other fertilizer with control group.

When shoot length was measured, there was significant difference among fertilizers on shoot length of each sampling plant. The maximum length of shoot noted with the application of urea i.e. 34.62 cm after 30 days and 72.19 cm after 60 days while manure showed 31.70 cm and 69.06 cm shoot length after 30 and 60 days, respectively. There was no significant difference between DAP and control group in shoot length as describe in Table (3). Similarly, maximum length of each plant parts were noted after application of urea i.e. root length 12.88 cm and 16.10 cm (Table 3), number of leaves 10.37 and 16.81 (Table 3), fresh weight of leaf 18.0 g and 32.65 g (Table 3), dry weight of leaf 4.03 g and 7.67 g (Table 5), fresh weight of root 44.22 g and 91.70 g (Table 6),dry weight of root 10.80 g and20.12g (Table 7) were recorded after 30 and 60 days, respectively. After urea, manure was a significant fertilizer when compared with control i. e. shoot length with manure 31.70 cm and 69.06 cm noted after 30 and 60 days, respectively. Manure is another organic fertilizer which supported plant growth.

In a same way in other plants parts manure showed significant results as compared to DAP and control group: 69.06 cm and 14.20 cm root length (RL), 9.25 and 14.75 number of leaves (NL), 16.82 g and 27.67 g fresh weight (FW) of leaves, 3.90 g and 6.93 g dry weight (DW) of leaves, 43.0 g and 86.71 g fresh weight (FW) of root, 8.91 g and 16.22 g dry weight

(DW) of root were recorded in manure after 30 and 60 days, respectively. In this present study these two fertilizers urea and manure significantly affect the seedlings growth of sun flower. When a comparison is done within these two, urea was significant as compared to manure but overall it was noted that these two are significant as compared with DAP and control.

There was no significant difference shown between DAP and control. It is noted that mostly readings were some time same or very close to each other. i.e. As shown in Table 8 the shoot length 27.58 cm and 63.83 cm in DAP while 27.42 cm and 62.14 cm in control were measured after 30 and 60 days, respectively.

Similar findings were recorded in other plant parts with these two treatments: 9.01 cm and 12.15 cm root length, 8.50 and 13.50 no of leaves (NL), 15.22 g and 25.36 g fresh weight of leaves, 3.10 g and 6.51 g dry weight (DW) of leaves, 41.10 g and 79.81 g fresh weight of root, 9.17 g and 16.20 g dry weight of root were recorded with the DAP treatment while 27.42 cm and 62.14 cm shoot length, 8.46 cm and 11.40 cm root length, 8.00 and 12.70 number of leaves, 12.72 g and 22.17 g fresh weight of leaves, 3.10 g and 6.41 g dry weight of leaves, 38.65 g and 78.28 g fresh weight of root, 8.55 g and 15.53 g dry weight of root were recorded with control group after 30 and 60 days, respectively. Over all urea and then manure remained significant among the fertilizers and showed maximum growth in vegetative parts of sunflower. These findings then compared with work of researchers done in past.

Similar findings shown by Adebayo *et al*., (2012) [12]. They investigated that addition of organic amendment increased both vegetative and yield of sunflower. They found that maximum values of plant height were recorded with organic manure.

Shanthi *et al*., (2012) [14] investigated that effect of urea on height of sunflower plants and concluded that urea play significant role in shoot length. Similar findings have been noticed in current study where urea showed significant effect on plant height. The reasons for same findings of current studies with those of past findings are may be due to same physical factor or soil conditions.

The results of under vision study are in agreement with those findings reported by Ali *et al*.,(2001) [2] who found that the stem height (shoot length) gradually increased with increase of nitrogen containing fertilizers (organic fertilizer).

Nasim *et al*., (2011) [10] stated that the improvement in the crop growth rate may be attributed to more vegetative growth due to N fertilizer application (organic fertilizers). These results validate the findings of Miralles *et al.,* (1997) who also indicated the positive effects of nitrogen on crop growth rate of sunflower crop. This research work is strongly correlated with above findings because urea is one of the nitrogen containing organic fertilizers which revealed its significant effects on crop growth rate.

Conclusion

It can be concluded from the above discussion that application of urea and manure (organic fertilizer) produced better growth in sunflower crop. The amendments of urea and manure fertilizer will increase the production of sunflower greatly if applied properly**.** Further research is considered necessary to study the effects of different fertilizers on seed germination and seedling growth of sunflower and to explore the impact various combinations of fertilizers on biomass and seed production yield that may be indicating gross increase in oil production from crop.

Table 1: Effect of different fertilizer on seed germination

Fertilizers	Effect on seed germination		
	Number of seed germination	Percentage of seed germination	Time of germination (Days)
Urea	35	87.5%	10
DAP	31	77.5%	14
Manure	34	85.0%	12
Control	29	72.50%	14

Table 2: Effect of different fertilizers on shoot length of *Helianthus annuus* L.

Parameters	Shoot length of *Helianthus annuus* L. (cm)	
	After 30 days	After 60 days
Urea	34.62* ± 0.15	72.19* ± 1.0
DAP	27.58** ± 0.40	63.83** ± 0.12
Manure	31.70* ± 0.22	69.06* ± 0.89
Control	27.42** ± 0.38	62.14** ± 0.25
EDF	12	12
EMS	0.373	1.89
LSD (0.05)	0.94	2.11

EDE=Error Degree of Freedom, EMS= Error Mean Square, LSD=Least Significance Difference α (0.05), each value is the mean ± Standard Error Mean of 4 replicates.* and ** represents significant and non-significant respectively.

Table 3: Effect of different fertilizers on root length of *Helianthus annuus* L.

Parameters	Root length of *Helianthus annuus* L. (cm)	
	After 30 days	After 60 days
Urea	12.88* ± 0.23	16.10* ± 0.43
DAP	9.01** ± 0.39	12.15** ± 0.38
Manure	10.91* ± 0.39	14.20* ± 0.15
Control	8.46** ± 0.51	11.40** ± 0.47
EDF	12	12
EMS	0.626	0.578
LSD (0.05)	1.21	1.17

EDE=Error Degree of Freedom, EMS= Error Mean Square, LSD=Least Significance Difference α (0.05), each value is the mean ± Standard Error Mean of 4 replicates.* and ** represents significant and non-significant respectively.

Table 4: Effect of different fertilizers on number of leaves of *Helianthus annuus* L.

Parameters	Number of leaves of *Helianthus annuus* L.	
	After 30 days	After 60 days
Urea	10.37* ± 0.37	16.81* ± 0.12
DAP	8.50** ± 0.54	13.50** ± 0.35
Manure	9.25** ± 0.95	14.75* ± 0.66
Control	8.00** ± 0.20	12.70** ± 0.42
EDF	12	12
EMS	0.828	0.771
LSD (0.05)	1.40	1.35

EDE=Error Degree of Freedom, EMS= Error Mean Square, LSD=Least Significance Difference α (0.05), each value is the mean ± Standard Error Mean of 4 replicates.* and ** represents significant and non-significant respectively.

Table 5: Effect of different fertilizers on fresh weight of leaves of *Helianthus annuus* L.

Parameters	Fresh weight of leaves of *Helianthus annuus* L.(g)	
	After 30 days	After 60 days
Urea	18.0* ± 0.21	32.65* ± 2.49
DAP	15.22* ± 0.31	25.36** ± 0.48
Manure	16.82* ± 0.63	27.67* ± 0.29
Control	12.72** ± 0.73	22.17** ± 0.62
EDF	12	12
EMS	1.08	6.89
LSD (0.05)	1.60	4.04

EDE=Error Degree of Freedom, EMS= Error Mean Square, LSD=Least Significance Difference α (0.05), each value is the mean ± Standard Error Mean of 4 replicates.* and ** represents significant and non significant respectively.

Table 6: Effect of different fertilizers on dry weight of leaves of *Helianthus annuus* L.

Parameters	Dry weight of leaves of *Helianthus annuus* L.(g)	
	After 30 days	After 60 days
Urea	4.03* ± 0.07	7.67* ± 0.19
DAP	3.10** ± 0.09	6.51** ± 0.18
Manure	3.90* ± 0.13	6.93** ± 0.08
Control	3.10** ± 0.09	6.41** ± 0.21
EDF	12	12
EMS	0.0397	0.124
LSD (0.05)	0.30	0.54

EDE=Error Degree of Freedom, EMS= Error Mean Square, LSD=Least Significance Difference α (0.05), each value is the mean ± Standard Error Mean of 4 replicates.* and ** represents significant and non-significant respectively.

Table 7: Effect of different fertilizers on fresh weight of roots of *Helianthus annuus* L.

Parameters	Fresh weight of roots of *Helianthus annuus* L.(g)	
	After 30 days	After 60 days
Urea	44.22* ± 0.49	91.70* ± 0.47
DAP	41.10** ± 0.84	79.81** ± 0.78
Manure	43.00* ± 0.86	86.71* ± 0.57
Control	38.65** ± 1.03	78.28** ± 1.12
EDF	12	12
EMS	2.78	2.43
LSD (0.05)	2.56	2.40

EDE=Error Degree of Freedom, EMS= Error Mean Square, LSD=Least Significance Difference α (0.05), each value is the mean ± Standard Error Mean of 4 replica

Table 8: Effect of different fertilizers on dry weight of roots of *Helianthus annuus* L.

Parameters	Dry weight of roots of *Helianthus annuus* L.(g)	
	After 30 days	After 60 days
Urea	10.80* ± 0.23	20.12* ± 0.35
DAP	9.17** ± 0.48	16.20** ± 0.19
Manure	8.91** ± 0.66	16.22** ± 0.27
Control	8.55** ± 0.58	15.53** ± 0.44
EDF	12	12
EMS	1.13	0.438
LSD (0.05)	1.63	1.01

EDE=Error Degree of Freedom, EMS= Error Mean Square, LSD=Least Significance Difference α (0.05), each value is the mean ± Standard Error Mean of 4 replicates.* and ** represents significant and non-significant respectively.

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