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PLANT GROWTH AND REPRODUCTIVE POTENTIAL OF RED POPPY (*PAPAVER RHOEAS* L.) AFTER IRON ($FeSO_4$) FERTILIZATION

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Abstract

Shoot height (58.00 cm) significantly (P = 0.05) increased at 500ppm $FeSO_4$ when compared with the control (36.33 cm). Peak (1.21g /plant) of shoot dry matter was also recorded at 500ppm $FeSO_4$. Leaf area (1647.06 & 2000.8 cm^2/plant) significantly (P=0.01) increased at 200 & 500ppm doses of $FeSO_4$. Highest seed output (13020 ± 342.80 seeds/plant) was recorded at 500ppm $FeSO_4$.

Key words : Plant growth, red poppy, shoot height, shoot weight, root depth, reproductive potential.

Introduction

Red poppy (*Papaver rhoeas* L.) member of Papaveraceae is thought to be the native of eastern Mediterranean. It is cultivated as an ornamental in upper India (Duthie, 1973). Plant is an annual herb growing up to 60 cm tall with white latex and slender roots. Plant is well known for its showy scarlet flowers. It is the country flower of Essex and Norfolk and a cultural icon associated with remembrance of World War I. It is known for key medicinal uses. Flowers have long been used in treating the earache, toothache and neuralgia. Petals are taken for the treatment of cough, insomnia and poor digestion. Seeds are of nutty taste and used for flavoring the cakes and bread. Leaves are cooked as vegetable and also used as salad (Davidson, 2006; Bown, 2008 and Mabberley, 2008).

Iron is essential micronutrient in plants because it is part of certain enzymes and numerous proteins that carry the electrons during photosynthesis and respiration. It undergoes alternate oxidation and reduction between F^{2+} and F^{3+} states acting as an electron carrier in proteins (Sandman & Böger, 1983b). Ferredoxins are the non-heme iron proteins participating in photosynthesis. These are small proteins containing iron and sulfur, mediating the electron transfer in a range of metabolic reactions. The chloroplast ferredoxins are involved both in cyclic and non-cyclic photophosphorylation. In non-cyclic photophosphorylation, ferredoxin is the last electron acceptor and reduces the enzyme $NADP^+$ reductase (Tagawa & Arnon, 1962). Cytochromes are other important iron-proteins playing a vital role in respiration and ATP generation via electron transport. These are the proteins containing heme groups. The heme groups are a highly conjugated ring system surrounding a metal. In most of the cytochromes, this metal is an iron atom. This iron atom inter-converts between Fe^{2+} and Fe^{3+} states, thus carrying out the redox reactions (Mac Munn, 1886; Reedy & Gibney, 2004). Fe^{++} acts in the enzymatic demethylation of DNA and RNA at 5' terminus as recently reported by Shen *et al*. (2014). Nutrients uptake of N, P, K and Fe in red poppy cultivated after $FeSO_4$ fertilization have recently been studied by Kumar *et al*. (2015). This piece of work deals with the growth and reproductive potential of red poppy cultivated on the soil with $FeSO_4$ fertilization.

Materials and Methods

Plants were raised in triplicates in two sets of black thick polythene bags of 12" × 8" size. Bottom of the pots were homogenously perforated to avoid the water logging in the soil. Doses of 10, 20, 50, 100, 200, 500 and 1000ppm (dry soil basis) of $FeSO_4.7H_2O$ were taken. Each dose was dissolved in 300 ml distilled water and thoroughly mixed in 5 kg air-dried light textured loamy soil by spreading on a polythene sheet. Sets of control were also prepared in identical manner except the doses. Seeds of

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Table 1 : Shoot height (SH), shoot weight (SW), root depth (RD), root weight (RW), leaf area (LA), number of flowers/plant (NFP), flower diameter (FD), number of seeds/capsule (NSC), seed weight/1000seeds (SW) and number of seeds/plant (NSP) of red poppy (*Papaver rhoeas* L.) cultivated after $FeSO_4$ fertilization.

S. no.	Doses (ppm)	SH (cm)	SW (g)	RD (cm)	RW (g)	LA (cm^2)	NFP	FD (Cm)	SW (mg)	NSC	NSP
1.	10	40.11 NS	0.39	10.60 NS	0.27 NS	638.13NS	4.33 NS	8.46 NS	84.0 NS	1061±28.43	4594±123.17
2.	20	38.20 NS	0.62**	15.30 NS	0.30 NS	684.0 NS	4.00 NS	8.20 NS	96.0 NS	1136±58.10	4544±240.00
3.	50	42.30 NS	0.64**	12.33 NS	0.32 NS	791.06 NS	4.00 NS	8.56 NS	92.0 NS	1277±20.67	5108±82.60
4.	100	46.10 NS	0.68**	14.00 NS	0.35 NS	1367.2*	3.66 NS	8.73 NS	115.0 NS	1253±33.60	4585±122.97
5.	200	52.60 NS	0.68**	15.66 NS	0.46 NS	1647.06**	8.48*	9.76*	121.0 NS	1618±44.78	13270±379.73
6.	500	58.00*	1.21**	14.66 NS	0.46 NS	2000.8**	8.40*	9.70*	134.0 NS	1550±40.81	13020±342.80
7.	1000	38.60 NS	0.62**	9.33 NS	0.25 NS	1114.06	4.33 NS	8.40 NS	132.0 NS	1186±42.30	5135±182.72
8.	Control	36.33	0.40	10.30	0.27	608.26	3.3	6.56	95.0	1125±40.40	3746±121.20
	SE (M)	7.25	0.01	2.30	0.115	229.06	1.85	1.18	20.0		
	CD at 1%	29.21	0.04	9.26	0.46	923.15	7.45	4.75	80.4		
	CD at 5%	19.30	0.02	6.11	0.30	609.33	4.92	3.13	53.2		

* = Significant at 5%, ** = Significant at 1%, NS = Non significant, ± SD.

red poppy were purchased from a local garden shop and the seed sowing was done on 23rd October 2013. Experimental pots were placed at a sunny open lawn for proper growth of the plants. After the germination plants were irrigated as when required.

Different growth parameters *viz*. shoot height and leaf area were recorded at pre-flowering stage, before bud bursting. Plants of first set were harvested approximately after 140 days of germination. Root depth of harvested plants was also measured. The plants were washed several times under the gentle tap followed with the jet of distilled water. Plants were air dried for 5-6 hrs. Then the fractionation of root and shoot components was carefully done and the samples were oven-dried at 60°C for 48 hrs to record the root and shoot dry weights.

Second identical set was used to record the total number of flowers/plant, flower diameter, number of capsules/plant and total number of seeds/plant. Data were tested for level of significance by applying analysis of variance (Anova) test.

Results and Discussion

Shoot height of red poppy increased at all the doses of $FeSO_4$ and recorded in the range of 38.20-58.00 cm. Peak value (58.00 cm) of shoot height was recorded at 500ppm $FeSO_4$, the difference was statistically significant (P=0.05) when compared with the control (36.33 cm). Shoot dry weight (0.39-1.21g/plant) significantly (P=0.01) increased with most of the doses except the 10ppm (0.39g/plant). Highest shoot dry weight (1.21 g/plant) was recorded at 500ppm $FeSO_4$. Root depth was recorded between 9.33–15.66 cm after $FeSO_4$ treatment but without any significant difference when compared with the control (10.30 cm). Root dry weight of the plants cultivated under the doses of $FeSO_4$ ranged between 0.25-0.46 g/plant but without any significant difference in comparison to the shoot dry weight (0.27g/plant) of the control. However, significant (P=0.01) differences were recorded in the leaf area (1647.06 & 2000.8 cm^2/plant) in plants raised at 200 and 500ppm doses of $FeSO_4$. Leaf area (1367.20 cm^2/plant) also significantly (P=0.05) increased with 100ppm dose of iron sulfate against the leaf area (608.26 cm^2) of the control (table 1).

There was a significant (P=0.05) increase in the number of flowers (8.48 & 8.40 flowers/plant) of the red poppy cultivated respectively at 200 and 500ppm $FeSO_4$ when compared with the control (3.3 flowers/plant). Flower diameter (9.76 & 9.70 cm) also significantly (P=0.05) increased at 200 and 500ppm doses of $FeSO_4$, over the control (6.56 cm). Highest numbers of the seeds (13020+342.80 seeds/plant) and the highest seed weight (134.0 mg/1000 seeds) were recorded in the plants cultivated at 500ppm $FeSO_4$ (table 1).

Plants need low amount of iron. Acidic soils have high levels of available iron and causing toxicity in plants but the soil, alkaline (pH>7) in reaction reduces the available iron in plants (Singh, 2009). A low supply of iron negatively affects the chlorophyll and other components of chloroplast thus reducing the plant growth. Iron functions as a component of cellular proteins in respiration and cell division. It has a role in transpiration, photosynthesis and chlorophyll synthesis (De la Guardia

& Alcantara, 2002). In present study, shoot height (58 cm/plant) significantly (P=0.05) increased at 500ppm $FeSO_4$.The shoot dry weight (0.62-1.21g/plant) also increased significantly (P=0.05) at most of the doses of $FeSO_4$. Root and shoot dry matter has been found to increase significantly after application of Fe-amino acid chelates in two tomato cultivars (*Lycopersicum esculentum* Mill. cvs. “Rani” & ”Sarika”). Tomato yield also increased by iron-amino acid chelates application in both these cultivars (Ghasemi *et al*., 2012). Plant dry weight and leaf area increased in *Citrus reticulata* when grown under 10^{-4}M Fe-EDTA, pH: 6 nutrient solutions in a grafting experiment (Incesu *et al*., 2015). Decreased plant biomass and leaf area have been reported in pea plants under Fe deficient conditions (Nenova, 2006; Nenova 2009). Application of $FeSO_4$ at lower rates (4, 8 & 12 $kgha^{-1}$) at the time of seed sowing significantly increased the plant growth and grain yield in wheat (*Triticum aestivum* L. cv. Bhaskar) in alkaline (p^H>7.3) soils of Pakistan (Khan *et al*., 2009). It can be concluded that medium doses (200-500ppm) of $FeSO_4$ increased the overall growth and reproductive potential of red poppy. The application of $FeSO_4$ can also be useful in promoting the growth and yield of crop plants in the alkaline and saline soils as per the dose requirement.

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