Nutrients (N, P& K) Uptake and Accumulation of Iron (Fe) in Red Poppy (*Papaver rhoeas* L.) under Different Fe Levels

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Abstract

Good amount (4.97%) of N was recorded in the shoot of red poppy with 500ppm $FeSO_4$. Lower values (3.06-3.73%) of N were observed in the root with $FeSO_4$ treatment when compared with the control (4.58%). P content decreased with increasing doses of $FeSO_4$ both in the root and the shoot. Peaks (2.75 & 2.50%) of K were observed in the shoot at 200 and 500ppm $FeSO_4$. Peaks (0.049% & 0.083%) of Fe were observed in the root and the shoot at 200ppm $FeSO_4$.

Keywords: Nutrients, Nitrogen (N), Phosphorus (P), Potassium (K), Iron (Fe).

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; Mabberley, 2008).

Materials and Methods

Plants were raised in triplicates in black thick polythene bags of 12"x8" 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. A set of control was also prepared in identical manner except the doses. Seeds of 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.

Plants were harvested approximately after 140 days of germination then washed several times under the gentle tap followed with the jet of distilled water. Plants were air dried for 5-6 hrs. Than the fractionation of root and shoot components was carefully done and the samples were oven-dried at 60^oC for 48 hrs. The dried samples were ground to 0.5 mm sieve. Nitrogen was estimated by micro-kjeldahl as per the method of Piper (1966). Phosphorus was estimated by spectrometric method under 420 nm blue filter using molybdate-vanadate reagent and potassium was estimated by flame emission method (Singh *et al*., 1999). Fe was determined by atomic absorption spectrometer (Perkin-Elmer Model 400) using standard protocol of Perkin-Elmer.

Results and Discussion

Fe is essential for chlorophyll synthesis, acting as an electron carrier in photosynthesis and respiration (Sandem & Böger, 1983b). It has a role in transpiration, photosynthesis and chlorophyll synthesis (De la Guardia & Alcantara, 2002). Plants need low amounts of iron, acidic soils have high levels of available iron causing toxicity to plants but alkaline (pH > 7) and saline soils provide low availability of iron to the plants (Singh, 2009). The low supply of iron negatively affects the chlorophyll content and other components of chloroplast, thus reducing the plant growth. Soil amendments with $FeSO_4$ increase iron availability, regulating the balanced uptake of N, P, and K in plants.

Nitrogen (N) is the most important nutrient for the plant growth and development. Lower N contents (3.43-4.97%) were observed in the shoot of red poppy grown with Fe treatment when compared with the control (5.01%), however good amounts (4.49 & 4.97%) of N were recorded in the shoot at 200 and 500ppm $FeSO_4$. Lower values (3.06-3.73%) of N were also recorded in the root with different doses of $FeSO_4$ when compared with the control (4.58%).

P content ranged between 0.20-0.32% in the root and 0.21-0.35% in the shoot of red poppy with $FeSO_4$ soil amendments. P content was found to decrease with the increasing doses of $FeSO_4$ both in the root and the shoot (Table1). Highest P concentrations (0.32 & 0.35%) were recorded in the root and shoot at 20ppm $FeSO_4$, whereas lowest P content (0.21 & 0.20%) at 1000ppm $FeSO_4$ soil amendments. It suggests that Fe supplementation decreased the P uptake in red poppy. Nutrient interaction is one of the important aspects for the manifestation of deficiency and toxicity symptoms in plants (Marschner, 1995). Deficiency and toxicity symptoms can be alleviated by increasing or decreasing other nutrients as in case of addition of extra potassium, the iron toxicity can be controlled (Li *et al*., 2001). Fe is always correlated with P because it can interact with P in the soil / growth medium, at the root surface and within the plant (Von Vexhall & Mutert, 1998). Plaques of Fe are formed that act as a barrier for the movement of P into the root (Zhang *et al*., 1999). Phosphorus is retained in the root and its translocation to the shoot decreases at high rate of Fe absorption (Mathan & Amberger, 1977). It has also been evident that Fe is found to link with P when it is bound in ferritin, suggesting that the ferritin-bound Fe is a potential plant sink for P (Waldo *et al.,* 1995).

K content increased with the increasing doses up to 200ppm $FeSO_4$ both in the root and the shoot. Highest K Contents (2.50 &2.75%) were recorded at 200ppm $FeSO_4$ in the root and the shoot then decreased. Lower concentrations (1.33 &1.16%) of K were observed in the root and the shoot of the control. Celik *et al*. (2010) have studied the nutrient uptake of K and Fe in maize (*Zea mays* cv. BSC 6661). This study reveals that increasing K and Fe levels had positive effects on dry weight of maize leaves and roots. Total Fe and active Fe concentrations and their uptake increased with the increasing levels of Fe and K; however doses of K more than 8mM and Fe more than 120uM decreased their uptake both in the roots and the leaves.

Increased amounts (0.071, 0.076, 0.077, 0.079 & 0.083%) of Fe accumulated in the shoot with increasing doses (10, 20, 50, 100 & 200ppm) of $FeSO_4$ then started to decrease (Table1). Control accumulated 0.071% iron in the shoot and 0.039% in the root comparatively. Lower values (0.035-0.049%) of Fe were recorded in the root when compared with the shoot (0.067-0.083%) with $FeSO_4$ treatment as shown in table 1.

It can be concluded that nutrients uptake of N, P, K can be best regulated between 200 -500ppm $FeSO_4$ in red poppy. Plant of red poppy (*Papaver rhoeas* L.) accumulates good amounts (0.049 &0.083%) of Fe in the root and the shoot, thus it can be used for the phyto-remediation of Fe polluted soils. The soils of Chambal division (M. P.) taken in this experiment have a good amount of K and are alkaline (pH >7) in reaction (Darra *et al*., 1970; Sharma *et al.,* 2004). These soils of alkaline and saline nature pose a serious problem of Fe and other nutrients availability. Soil amendments as per the dose requirement of $FeSO_4$ can also regulate the homeostasis of N, P and K, the basic nutrients to increase the growth and yield in crop plants of alkaline and saline soils.

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Table 1: Nutrients (N, P, K, & Fe) contents (%) in red poppy*

		In the root				In the shoot			
S.No.	**Doses**	**N**	**P**	**K**	**Fe**	**N**	**P**	**K**	**Fe**
01	10	3.69	0.30	1.00	0.035	4.27	0.35	1.08	0.071
02	20	3.57	0.32	1.41	0.039	3.92	0.35	1.25	0.076
03	50	3.46	0.28	1.91	0.047	3.43	0.30	1.91	0.077
04	100	3.62	0.25	2.33	0.048	4.12	0.30	2.36	0.079
05	200	3.73	0.22	2.50	0.049	4.49	0.22	2.75	0.083
06	500	3.44	0.23	1.91	0.038	4.97	0.21	2.50	0.082
07	1000	3.06	0.20	2.16	0.038	4.14	0.22	2.41	0.067
08	Control	4.58	0.35	1.33	0.039	5.01	0.40	1.16	0.071

***Data based on three replicates**