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# EFFECT OF POTASSIUM ON INDUCTION OF BIOCHEMICAL DEFENCE AGAINST RUST IN WHEAT

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The effect of potassium on germination, seedling vigour and defence related enzymes viz. perodixase, catalase, lipid peroxidation, superoxide dismutase and phenylalanine ammonia-lyase in wheat is studied in the present investigation. The experiments were carried out on rust susceptible wheat var. 'Agra local' treated with different concentrations of potassium ( 100, 200, 300 and 400 ppm). The results indicated that potassium at 100 and 200 ppm concentration manifested highest germination percentage while the concentrations 300 and 400 ppm had inhibitory effect. Seedling growth was stimulated by 100, 200 and 300 ppm concentrations and maximum stimulation was obtained at 200 ppm concentration. Wheat seedlings exhibited gradual increase in activity of all oxidative enzymes upto concentration 300 ppm of K. The highest stimulation was shown at 200 ppm concentration, except for superoxide dismutase which exhibited highest stimulation at 100 ppm of K. 400 ppm K showed reduction in the activity of all enzymes, but this reduction was not below the level of control value. Thus, besides promoting germination and seedling growth, potassium also has a positive role in stimulating the activity of defence related enzymes. So it can be concluded that treatment of potassium during germination is useful to induce biochemical defence against biotic stress like epidemic of rust.

**Keywords** : Enzymes; Germination; Potassium; Seedling growth; Wheat.

## Introduction

The control of diseases through nutrient management is a novel approach and hence the alternative environmental friendly method of disease control through balanced mineral nutrition and developing host resistance through metabolic defence mechanism is utmost important[1,2]. There is extensive literature on the interaction of nutrients and plant diseases with potassium (K) having the major role in plant health[3-5]. Potassium is involved in nearly all cellular functions that influence disease severity, because it acts as a regulator of enzyme activity. K seems to be effective in increasing resistance against fungal and bacterial diseases by inducing metabolic defence.

Wheat is the major crop grown extensively in Maharashtra and it suffers largely due to various fungal diseases. Among these, rust disease is highly destructive and is responsible for wide spread epiphytotics all over India[6]. The yield of this crop is going down largely due to rust infection[7]. Therefore, in the present investigation, the effect of potassium on induction of biochemical defence *via* seed germination, seedling vigour and defence related enzymes against rust in wheat is studied.

## Materials and Methods

The surface sterilized seeds (20) of wheat (*Triticum aestivum* L.) var. 'Agra local', obtained from Regional Wheat Rust Research Station, Mahabaleshwar, Dist. Satara, were kept in sterilized petridishes ( 9 cm in diameter) over Whatman No. 1 filter paper at room temperature ( 28 to 30°C ). The filterpaper was moistened with 10 ml glass distilled water in control and potassium (100, 200, 300 and 400 ppm) in respective petridishes. Potassium was used in the form of $KNO_3$. The germination of seeds were observed upto 72 hrs at an interval of 24 hrs. The root, shoot length was recorded from third to seventh day at interval of 24 hrs. The activity of various enzymes was also studied in 72 hrs old seedlings. The activity of peroxidase was studied by the method of Maehly[8], catalase by Sadasivam and Manickam[9], lipid peroxidation by Carkmak and Hort[10], superoxide dismutase by Giannopolitis and Ries[11] and phenylalanine ammonia-lyase by Mahadevan and Sridhar[12].

## Results and Discussion

Minerals influence the growth and development of plants in different ways. Potassium plays an important role in induction of disease resistance in plants[5]. Hence, before applying this chemical to a crop, it is important to study its effect on plant growth starting from germination. The germination percentage in 100 and 200 ppm concentration

**Table 1.** Effect of potassium on root and shoot length of wheat var. 'Agra local'.

| Hours (h) | Control | | 100 ppm | | 200 ppm | | 300 ppm | | 400 ppm | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Root | Shoot | Root | Shoot | Root | Shoot | Root | Shoot | Root | Shoot |
| 72 | 4.7±0.37 | 3.6±0.47 | 4.5±0.47 | 5.6±0.48 | 3.8±0.29 | 5.7±0.48 | 3.5±0.58 | 5.5±0.41 | 2.8±0.58 | 4.8±0.57 |
| 96 | 5.1±0.75 | 5.0±0.36 | 5.1±0.72 | 8.2±0.48 | 6.1±0.34 | 8.2±0.91 | 5.0±1.34 | 8.2±0.47 | 4.0±0.96 | 6.6±0.57 |
| 120 | 5.2±0.44 | 7.5±0.0 | 5.7±0.62 | 8.7±1.68 | 7.0±0.92 | 14.2±0.58 | 6.7±1.68 | 13.7±0.65 | 5.5±0.74 | 11.5±0.37 |
| 144 | 6.9±0.35 | 9.3±0.67 | 6.2±0.20 | 13.6±0.43 | 7.8±0.48 | 17.4±0.47 | 7.8±0.75 | 15.6±0.46 | 6.2±0.23 | 14.7±0.53 |
| 168 | 8.0±0.64 | 11.7±1.20 | 7.6±0.40 | 16.1±0.24 | 8.7±0.47 | 20.3±0.41 | 8.9±0.14 | 18.2±0.57 | 6.9±0.32 | 17.6±0.44 |

of K showed highest germination (94 %) but 300 and 400 ppm of K exhibited reduction in germination percentage (84 and 76 % respectively) as compared to control (88%). The effect of potassium on root and shoot length in wheat is given in Table –1. The root length decreased by 100 ppm concentration of K but stimulated by 200 and 300 ppm, and inhibited by 400 ppm potassium. On the contrary, the shoot length was greatly promoted by all the concentrations of potassium, the maximum being noted at 200 ppm.

Seed germination is an important event in the life cycle of plant, which determines survival of most plant species in the biosphere. According to Sinha[3] foliar application or seed treatment by potassium brings out spectacular changes in improving yield and ability to withstand biotic stress of crops. Sarkar *et al.*[13] found increase in the growth parameters and yield attributes due to foliar application of potassium nitrate (0.25%) in groundnut. Umar *et al.*[14] reported stimulatory effect of K on dry matter accumulation in jowar. Bhargava and Banerjee[15] reported stimulation of root growth at lower concentrations of N and K and inhibition at higher doses in potato.

The effect of potassium revealed stimulation in the peroxidase activity by 100 % over control in wheat at 200 ppm of K. None of the other concentrations of potassium reduced the activity below the level of control (Fig. 1). Peroxidase plays pivotal role in lignin synthesis, and auxin catabolism[16], which clearly indicates role of peroxidase in plant growth and development. There is a report on effect of salicylic acid on peroxidase activity in *Impatiens balsamina* showing stimulation[17]. Similarly the radish leaf disc treated with quinines also exhibited stimulatory effect on peroxidase activity. In the present investigation we also found increase in peroxidase activity by potassium treatment. The increased peroxidase activity may lead to decrease the intensity of oxidative stress in potassium treated seedlings.

Potassium also exerted stimulatory effect on enzyme catalase at 200 ppm concentration but higher concentration exhibited reduction in the activity (Fig. 1). Catalase is an important enzyme in the process of germination. According to many workers catalase activity is correlated with the germination capacity and seedling growth[18]. The enzyme catalase converts $H_2O_2$ to $H_2O$ and $O_2$, and protects cells from the damaging effects of $H_2O_2$. The activity of catalase studied in mango leaves infected with *Colletotricum gloesporioides* was found to be increased about three times more than healthy leaves[19]. Similarly Mahanda *et al.*[20] reported increase in catalase activity in papaya plants inoculated with VAM fungi. The stimulation of catalase activity in lower concentrations of potassium can increase the resistance of seeds to oxidative stress and cause growth stimulation of the seedlings. This may ultimately help in induction of defence mechanism in plant.

Malondialdehyde (MDA), decomposition product of lipid peroxidation present in host cell membranes is often found to increase during pathogenesis. Since potassium plays important role in developing defence mechanism against pathogen, its effect was studied on defence related enzymes lipid peroxidation and superoxide dismutase in wheat. It is vividly clear from the results (Fig. 2 and 3) that the lipid peroxidation and superoxide dismutase activity was comparatively high in all the concentration of potassium. The highest activity of lipid peroxidation was observed in 200 ppm of K and that of superoxide dismutase in 100 ppm of K. Though the higher concentrations of K (300 and 400 ppm) showed reduction in the activity of both the enzymes, this

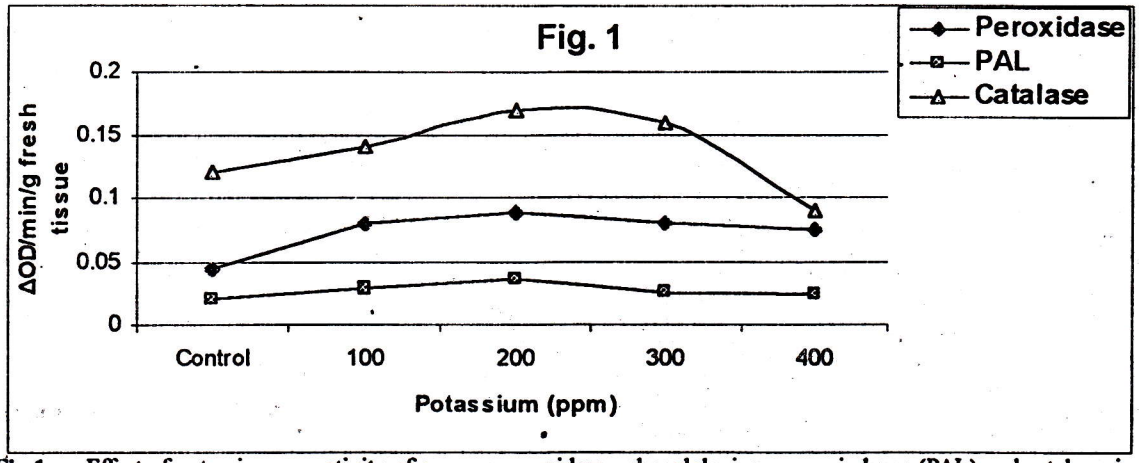


**Fig.1.** Effect of potassium on activity of enzyme peroxidase, phenylalanine ammonia-lyase (PAL) and catalase in wheat var. 'Agra local' after 72 h of germination.

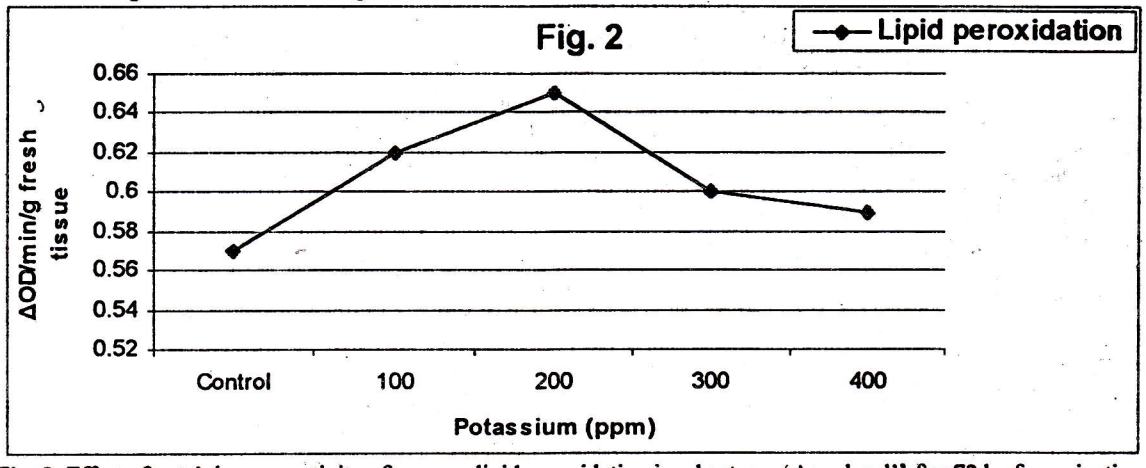


**Fig. 2.** Effect of potassium on activity of enzyme lipid peroxidation in wheat var. 'Agra local' after 72 h of germination.

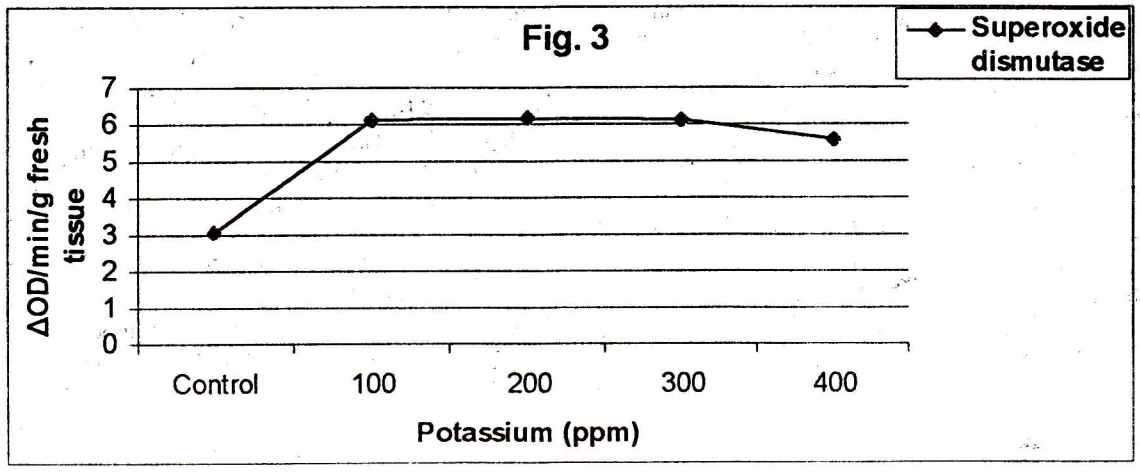


**Fig. 3.** Effect of potassium on activity of enzyme superoxide dismutase in wheat var. 'Agra local' after 72 h of germination.

reduction was not below the level of control.

lipid peroxidation is a widely used stress indicator of plant membranes and it has been shown to mediate photoperoxidative damage and distribution of chlorophyll[21]. It also causes drought induced increase in membrane permeability[22]. Recently, Chaudhuri and Chaudhuri[23] have recorded a high degree of membrane damage in sensitive jute cultivars, due to the increased rate of lipid peroxidation in response to salinity stress. In plants, the role of superoxide dismutase (SOD) during environmental adversity such as drought, chilling, hypoxia, high temperature, high light intensity and pathogenic injury have been correlated with SOD activity[24]. In the present investigation, the higher rates of lipid peroxidation and superoxide dismutase suggest enhanced production of activated oxygen species as a result of potassium treatment.

Phenylalanine ammonia-lyase (PAL) studied in wheat seedlings under the influence of potassium showed the marked stimulation at 200 and 300 ppm of K (Fig. 1). Like that of other enzymes, the higher concentration of K showed inhibitory effect on the enzyme activity. Phenylalanine ammonia-lyase is the key enzyme in the phenyl propanoid pathway catalyzing synthesis of phenols, lignin and phytoalexins from L- phenylalanine[25]. The enzyme is related to defence responses of cereals to pathogenic microorganism[26] and it is often considered as an indicator of resistance in the host plant[27]. It is also reported that the increased activity of PAL is a host response associated with the synthesis of phytoalexins[28]. The stimulation of PAL activity in the present investigation under the influence of potassium will certainly help in development of resistance in wheat plants.

The perusal of the data indicates that increased germination and enhanced seedling vigour under influence of K treatment lead to establishment of good and healthy crop stand, which ultimately results in better productivity. All the concentrations of potassium exhibited stimulation in enzyme activity. This indicates the potentiality of potassium in induction of defence mechanism against the biotic stress.

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