

NITROGEN USE EFFICIENCY (NUE) AND POTASSIUM

Role of K in improving NUE

K APPLICATION



Yield & quality of crops

Tolerance to pests & diseases

N utilization



Adverse effect of excess N

Nitrate in profile

Nitrate pollution of water



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Importance of N and K

Nitrogen and potassium are essential major nutrients. Both play important role in growth and development of plants. Plants take both of them almost in the same quantities but their application to crops in India varied widely.

What role potassium plays?

- Potassium activates over 80 cellular enzymes
- Potassium improves plant's ability to resist disease and cold
- Potassium enhances fruit quality
- Increases root growth and improves drought resistance
- Potassium is essential for:
 - ◆ photosynthesis
 - ◆ protein synthesis
 - ◆ nitrogen fixation
 - ◆ starch formation
 - ◆ translocation of sugars

What role nitrogen plays?

- Nitrogen is a part of all living cells and is part of all proteins, enzymes and metabolic processes involved in the synthesis and transfer of energy.
- Nitrogen is a part of chlorophyll; the green pigment of the plant that is responsible for photosynthesis.
- Nitrogen helps plants with rapid growth, giving the plant a healthy green color.

What is N x K interaction?

When we apply N and K individually the yield is increased due to application of either of the elements. But, when we apply both N and K together, the increase in yield is greater than the sum of increase in yield due to N and K separately (Fig 1)

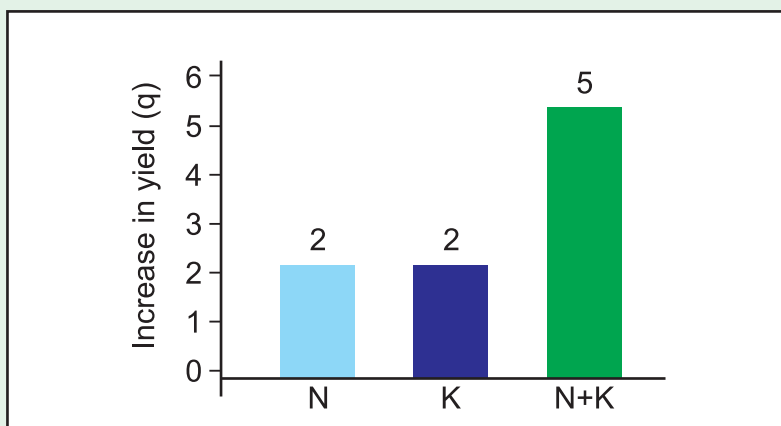


Fig. 1. Interaction effect of N and K

The graph indicates that additional 1q yield is due to increase in NUE due to K application.

How K improves N use efficiency ?

Higher rates of K applied to the crop allows better N uptake and utilization (improved N use) and results in higher yields.

Why to improve N use efficiency?

- An improved NUE means that farmers can apply less N fertilizer without affecting yield, therefore savings of N fertilizer are achieved with :
 - ◆ Higher profits to the farmer
 - ◆ Better environmental stewardship

NUE and balanced fertilization with K

Dozens of experiments conducted by IPI demonstrate the role and scale of effect of potassium on NUE. In these experiments, a typical K application of 30-150 kg K_2O /ha can increase NUE by approximately 10-40%.

At a given level of N application, addition of increased level of K not only increased the grain yield but also improved the NUE by 6 to 29% in wheat, 18% in sunflower and to the extent of 70% in sugarcane (Table 1).

Table 1: Increase in yield and NUE achieved at IPI on-farm experiments in India

Crop	Parameter	N rate (kg/ha)	K rate (kg/ha)	Yield increase (kg/ha)	Increase in NUE (%)
Wheat	Grain	125	30-90	200-1300	6-29
Sunflower	Seeds	60	30-90	400	18
Sugarcane	Cane	240-360	85-200	2200	70

(Source: e-ifc 13, IPI)

The immediate gain from balanced fertilization with potassium is described in Figure 2

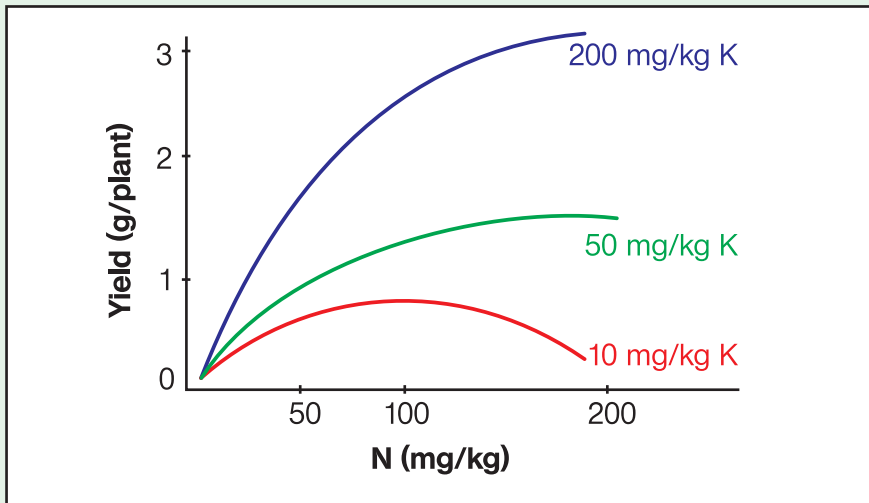


Fig. 2. Effect of N and K interaction on barley yield in hydroponic culture

(Source: e-ifc 13, IPI)

- At low K level an increase in N supply depressed yield of barley
- At medium rates of K, the increased rates of N improved the yield
- Maximum yield could only be obtained at high levels of both N and K

A positive N x K interaction in rice is shown in Fig. 3

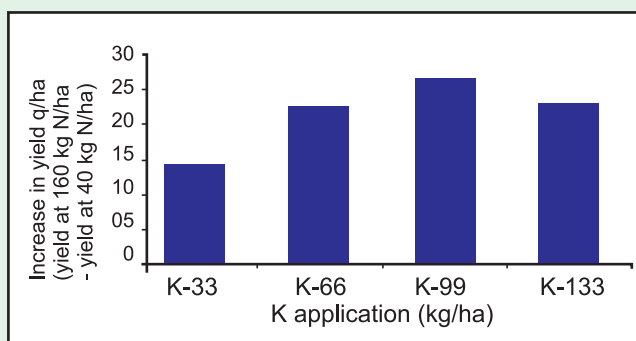


Fig. 3 Effect of increasing N dressing (yield at 160 kg N/ha - yield at 40 kg N/ha) on yield of rice at different levels of K application (Source: Mondal et al., 1982)

The benefit in the form of increase in yield with increase in N levels is less at low levels of K application but increased with increased levels of K application.

There is better utilization of applied N at high levels of both N and K application with a proper balance

Greater yield response to N occurs when K is sufficient Table 2)

Table 2. Increase in yield of cassava (q/ha fresh tuber) with increase in K levels at a fixed N level of 50 kg N/ha

K applied (kg/ha)	Increase in yield at 50 kg N/ha
0	36
80	107
250	142

(Source: Muthuswami and Chiranjivi Rao, 1979)

In Tamil Nadu the optimal rate of fertilizer to cassava was worked out to be 50 kg N /ha and 250 kg K/ha. The interaction effect indicated

- A very little response to the application of N in the absence of applied K.
- The yield increased tremendously with the increase in levels of applied K.

Potassium application insured the utilization of N and storage of carbohydrates in roots thus improving the NUE.

N x K interaction and crop quality

Protein content and yield of pearl millet

An important aspect of N x K interaction is its effect on quality of crops which is depicted in table 3

Table 3. Effect of K application on protein content and yield in pearl millet on light textured soils of Haryana

Treatment	Protein content (%)	Protein yield (kg/ha)
K ₀	9.89	320
K ₂₀	10.51	335
K ₄₀	10.95	350
K ₆₀	11.61	370

(Source: e-ipc 13, IPI)



On light textured soils in southern Haryana, K application increased the quality of pearl millet by increasing protein content and yield indicating better utilization of applied N thus improving the NUE.

Starch content in cassava

The starch content of cassava is also positively influenced by the interaction of N and K (Table 5).

Table 5 : Effect of N x K on starch yield (q/ha) of casava

K Level	N Level	
	0	50
0	46.3	63.0
100	57.3	70.9
300	59.6	89.4

(Source: Muthuswami and Chiranjivi Rao, 1979)

N x K interaction and disease tolerance

- High nitrogen dressing produces soft growth, which is more susceptible to plant diseases in rice (Table 6).
- Potassium acts in the opposite direction and increases the tolerance to diseases.

Table 6 : Effect of N and K fertilizers on diseases in rice

Treatment (N-P-K)	Stem rot index	Sheath blight
120-0-0	69.2	59.8
120-60-60	4.4	55.0
120-60-120	1.8	48.0

(Source: Ismunadji and Partohardjono 1979, IPI Research Topics No. 13)

In rice, the lesion length of bacterial leaf blight increased with increase in levels of applied nitrogen both at low and medium levels of applied K (Fig. 4). The high level of K reduced it even at highest level of applied N.

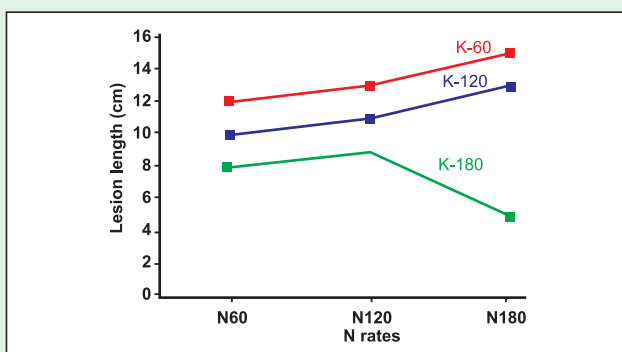


Fig. 4. N and K interaction and bacterial leaf blight of rice
(Source : Devadath and Padmanabhan, 1970)

N x K interaction and environment quality

Studies in Punjab, indicate that unbalanced fertilizer application to wheat crop resulted in decreased NUE, which in turn leads to increasing amount of unutilised mineral nitrogen in soil, which may become a potential source of ground water pollution (Fig. 5).

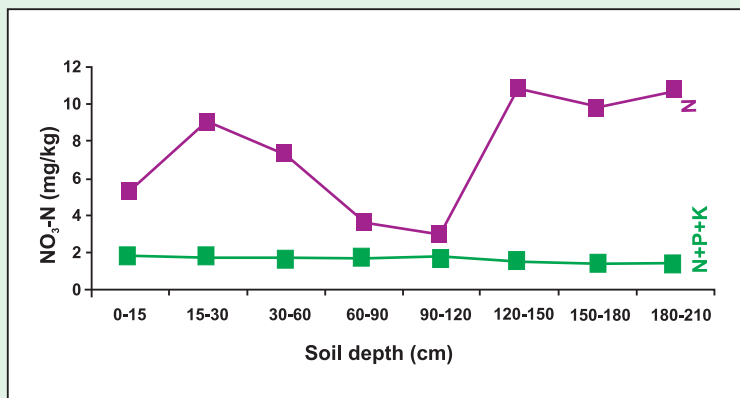


Fig. 5 Effect of fertilization of NO₃-N content in soil profile
(Source: Bijay-Singh and Sekhon, 1986)

Increase in NUE due to K application means more utilization of N by the crop and less amount of N polluting the environment

- Balanced fertilization with K is an immediate, low-cost tool to achieve a higher NUE
- A gain of 20% in NUE can be easily achieved via balanced fertilization with potassium
- Adequate potassium increases both nitrogen absorption and reduction to amino acids and protein formation in plants - thus improving yield, quality and NUE
- Balanced fertilization with potassium increases crop yields and profits while enhancing NUE for the protection of the environment.

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