Role of Guard-cop to catalyse copper absorption and it's effect on various physiological parameters in wheat (*Triticum astivum*) *from Cu- Fertilizer applied in soil and Copper hydroxide foliar spray .*

SUMMARY

In house testing conducted by R&D team on Wheat(Triticum astivum) in the field of Sri Prabhat Kumar Singh a progressive farmer of the Wheat growing growing district of Vaishali district in the state of Bihar with Guard-cop for eavluate the efficacy & benefits on copper sensitive wheat crop in combination with the recommended dose of copper fertilizer in soil as well as copper fungicide foliar application . Different growth , yield attributing characters and yield on harvest of Wheat (Triticum astivum) were scientifically studied during *Rabi season (winter)* in 2011 in Wheat (Triticum astivum) producers field in 24 Parganas (N) .

The effect of different treatments (T_1 ,T_2 ,T_3, T_4, T_5) of Guard- Cop 93 g/l copper in combination with the recommended dose of Copper fertilizer on different parameters it was observed that at Control the results in all parameters were very low in comparison to other treatments . Solo application of Guard-Cop @ 400 ml / acre where LAI raised to 3.95 from 2.74 that to yield & karnel plumpness changes are from 1.1 to 1.4 and 19 to 22 respectively which is surely the effect of better copper absoption catalyzed by Guard- Cop.

Maximum yield benefit was recorded in combination Treatment4 (T_5) of Cu-Fert. Broadcast + Guard-Cop spray where the Cu absorption effect has been rapidly noticed in all the parameters to its significant yield to 2.92 Mt / Acre with recorded LAI and Kernel Plumpness as 4.89 & 52 respectively. But optimum yield with optimum input application is also significant in T_4 .Guard-cop also demonstrated significant result in controlling Rust (Puccinia triticina f.sp. tritici) .

INTRODUCTION

Copper (Cu) is an essential nutrient for plant growth, but because only a small amount is needed, it is classified as a micronutrient. Organic or peat soils are exceptions and Cu might be needed in a fertilizer program when cereals like wheat , Corn are grown on these soils. Wheat is the most sensitive to Cu deficiency. Cu absorption in wheat will increase their yield when grown on organic soils.

Copper is an important component of proteins found in the enzymes that regulate the rate of many biochemical reactions in plants. Plants would not grow without the presence of these specific enzymes. Copper promotes seed production and formation , plays an essential role in chlorophyll formation , is essential for proper enzyme activity .

CAUSE & EFFECT OF COPPER DEFICIENCY SYMPTOMS & ANALYSIS :

In the Vaishali Taluka of Vaishali district in the village Chintamanipur, in the state of Bihar, evidence of Cu deficiency has appeared when wheat is grown on organic soils . Symptoms of Cu deficiency are almost ignored in production fields in this area. These deficiency symptoms are characterized by a general light green to yellow color in wheat crop. The leaf tips die back and the tips are twisted. A typical deficiency symptom for wheat is shown in Figure 1. If Cu deficiency is severe enough, growth of small grains ceases and plants die after reaching the tillering growth stage. Wheat will not have grain in the head. Deficiency symptoms have only been observed when small grains are grown on peat soils.

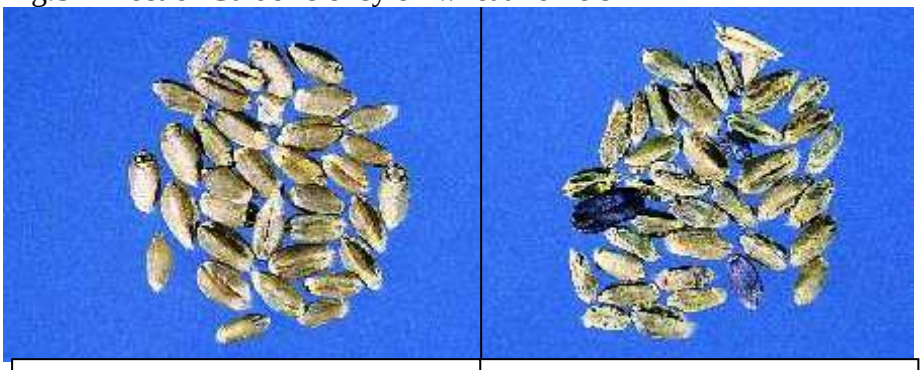
Figure 1. Cu deficient Wheat plant shows sign of leaf tips die back and they are twisted.

If a soil test indicated more than 0.2 ppm Di-ethylene-triamine-penta-acetic-acid (DTPA) extractable Cu, then the soil was determined to have sufficient Cu for normal crop growth. The amount of Cu available to plants varies widely by soils. Available Cu can vary from 1 to 200 ppm (parts per million) in both mineral and organic soils as a function of soil pH and soil texture.

Fig2. Bleached & grey heads of wheat with stems are significantly darken due to melanosis grown in Cu deficient soil .

The finer-textured mineral soils generally contain the highest amounts of Cu. The lowest concentrations are associated with the organic or peat soils. Availability of Cu is related to soil pH, with the increase in soil pH the availability of this nutrient decreases. Copper is not mobile in the soil hence get attracted to the soil organic matter and clay minerals. The amount of available Cu was measured by extracting the soil with a DTPA solution the concentration of Cu in the extract is then measured , this procedure is the most reliable and accurate for measuring Cu in soils.

Fig:3 Effect of Cu deficiency on wheat kernels



Normal Wheat. Grains	Shrivelled Wheat kernels (frosted bran) and ergots due to a Cu deficiency

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Fig:4 Effect of Cu deficiency on wheat panicles & panicle stem.

Normal Wheat. Grains in panicles	Wheat panicles with severe Cu deficiency Symptoms

Cu deficiency in cereals produces characteristic disease symptoms that may be similar among cereal crops. However, crop growing on marginally Cu deficient soils has registered ±20 % loss of grain yield while not showing any typical visual symptoms of Cu deficiency. 7 - 14 days delayed crop maturity has also been noted , resulting in greater foliar disease instances and a much greater risk of frost injury to the maturing grain in winter wheat. Visual symptoms of Cu deficiency on Wheat panicles & kernels (Fig 3 & 4) are commonly observed in fields. Many of these disease symptoms may be confused with other nutrient deficiencies (N, P, K, or S), frost damage, insect damage, infectious diseases and herbicide damage.

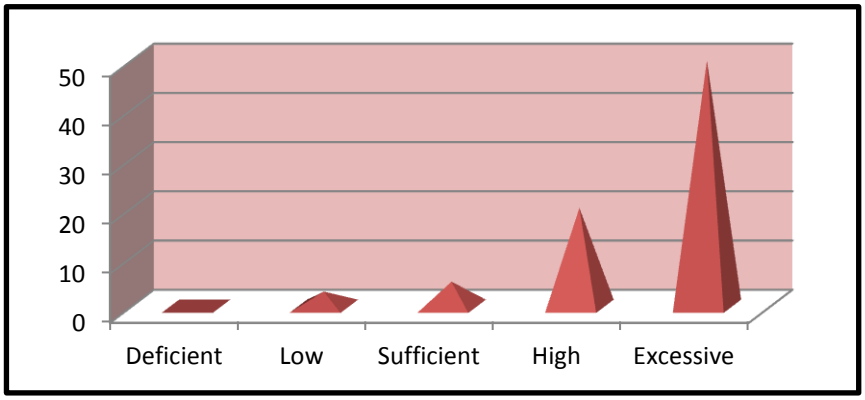
Herbicides are commonly blamed for yield losses because Cu deficiency symptoms usually show up about the same time when post-emergent herbicides are applied. At times post-emergent herbicides may enhance Cu deficiency as well as delay crop maturity.

Fig: 5 Herbicide wheat interaction (leaf tip burning) on copper

In Variety PBW 443 Cu deficiency symptoms usually occur in irregular patches and are most obvious in mature wheat stands that express Cu deficiency primarily as melanism or purplish brown patches. K Variety 9107(Deva) has a history of showing Cu deficiency primarily like " take-all " type symptoms which adds further confusion to Cu diagnoses . During this trial a significant observation has been noted that, Guard-Cop application in copper-deficient wheat resulted in advancing the crops maturity by a week to a fortnight period along with positive benefits to grain yield .

Table 1. Interpretation for concentration of Cu in plant tissue.

Crop	Plant Part Sampled	Time of sampling	Deficient	Low	Sufficient	High	Excessive
					----------ppm Cu----------		
Wheat	Top leaves	Boot stage	< 3.0	3.0 - 5.0	5.1 - 20.0	20.1 - 50.0	>50



Farmers / growers who ignore or do not manage soil fertility at an optimally level or keep high optimal level generally their harvested yields that get limited by nitrogen (N), phosphorus (P), potassium (K) or sulphur (S) with deficient Cu situation can affect yields. Farmers / growers striving for optimal yields are generally the first to observe Cu deficiency in a farming area. Their fertility management often includes manure and above average rates of fertilizer. In many instances, their first indications of Cu deficiency are crop yields or bushel weights consistently below their expectations.

Table 2. Summary of Copper deficiency symptoms in Wheat and the degree of deficiency observed.

Sl	Symptoms	Degree of Deficiency		
		Slight	Moderate	Severe
1	Limpness or wilting at mid-tillering			x
2	Limpness or wilting at mid-tillering at stem elongation	x	x	
3	Pale yellow, curled young leaves at tillering			x
4	Pig tailing (Whip tailing) - leaf tip dies and may roll and turn white, sometimes appearing fibrous. Upper 1/3 to 1/2 of the leaf may wither and break abruptly at the healthy part.		x	x
5	Increased susceptibility to disease		x	x
6	Presence of ergots in grain heads, specifically wheat and barley.		x	x
7	Unusually high levels of "take-all" or "take-all" like symptoms in wheat.		x	x
8	Retarded stem elongation		x	x
9	Excessive late tillering and high mortality of late tillers.		x	x
10	Delay in heading - Non-uniform heading occurs, particularly on light loamy soils where crop emergence and early development is uniform.		x	x
11	Aborted heads and spikelets.		x	x
12	Heads and spikes are nearly normal, but contain many empty spikelets.Anthesis is poor and late. Grain is shrivelled and endosperm is blackened.		x	x
13	Delay in maturity and senescence - Maturity may be delayed for a few days to several weeks.			x
14	Head and stem bending - stem may break 15 to 30 cm below the head.		x	x
15	Stem and head melanosis of wheat - Dark brown patches that usually begin at the milky dough stage. Dark purplish brown colour (melanism) appears on head and/or upper stem and/or lower stem.		x	x
16	Probable loss in grain yield (%)	5 - 20	20 - 50	50 - 100
17	Probable loss in straw yield (%)	Nil	1 - 10	10 - 20

Adapted from Graham and Manbiar, 1981

MATERIALS AND METHODS

Field experiments were conducted at the Wheat (Triticum astivum) field of the grower Sri Prabhat Kumar Singh ,Village: Chintamanipur,Post Office(B.O): Madarna,Pin-code 844113 , District,Vaishali State: Bihar ,following RCBD with 5 treatments (as enumerated in the tables) to evaluate 5 factors of Winter (*Rabi season)* wheat in the year 2011- 2012 .Wheat cultivar PBW 443 was planted on in 5 x 5 m^2 plots following 10 cm X 10 cm spacing. Recommended dose of fertilizer i.e. 90 Kg N, 35 Kg P_2O_5 and 35 Kg K_2O were applied as basal and top dressing and standard agronomic practices were followed. Copper Sulphate, blue stone or blue vitriol are all common names for pentahydrated cupric sulphate, $CuSO_45H_2O$, which is the best known and the most widely used of the copper salts. Indeed it is often the starting raw material for the production of many of the other copper salts.

Presently the world's consumption is around 200,000 tonnes per annum. It is estimated that approximately three-quarters of this is used in agriculture, principally as a fungicide, but also for treating copper-deficient soils.

GUARD-cop is an unique environmental friendly a non-systematic , preventative shield product against fungal & bacterial diseases of crops working as a catalytic agent that augment copper absorption, contains active ingredients 93g/l copper (cu) . Once mixed with water, GUARD-Cop forms a shield gel with its in built spreading and sticking ability, gives an unique micro-thin cover of copper hydroxide crystals on to the plant leaf surface. As the median particles sizes for crystalline coppers of GUARD-Cop is 0.3 micron whereas normal copper are 0.7-3.1 micron hence GUARD-Cop has high penetrative efficacy over the others in the same segment.

Results presented in Table 3 are typical of the initial experience many producers have with Cu deficiency. In this situation, the farmer had been applying optimal rates of fertilizer and manure every three to five years. Yields, quality and weed control were disappointing, and many agronomists had given several different reasons why yields were lower than expected. With the application of Cu, crop quality and yield both improved dramatically.

Table 3. Role of Guard- Cop in Copper absorption & effect on physiological parameters in wheat Crop .

Nos. of Treatment	Treatment Application	Cu-Fert Rate* (Kg / Acre)	Guard-Cop Dosage ml / Acre	LAI 15 DAF	Yield (Mt / Acre)	% Kernel Plumpness	1000-grain Weight (g)	Maturity Duration
T_1	Control	Nil	Nil	2.14	0.75	15	27.32	122
T_2	NPK + Cu-Fert. Broadcast	1.5	400	3.87	1.2	20	44.32	120
T_3	NPK + Guard- Cop spray	0	400	3.95	1.4	22	45.18	115
T_4	NPK + Cu-Fert. Broadcast + Guard- Cop spray	1.5	400	4.61	2.31	36	46.09	112
T_5	NPK + Cu-Fert. Broadcast + Guard-Cop spray	4.5	400	4.89	2.92	52	47.56	110

LAI - Leaf Area Index

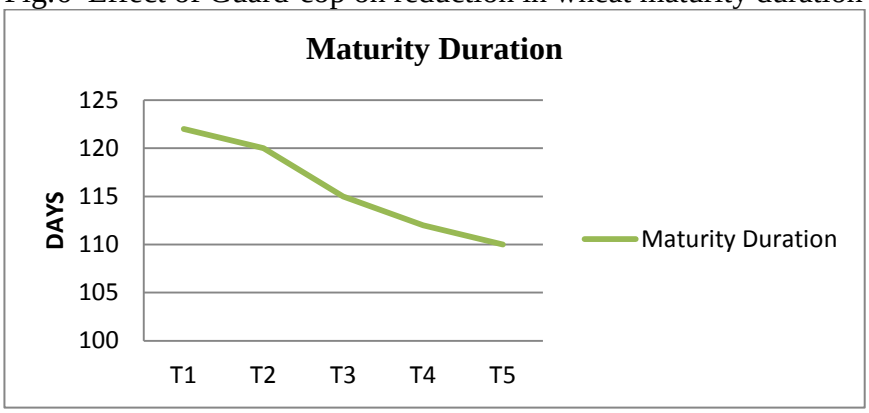
*Copper applied as Copper Sulphate.

Comparative observation of T_4 & T_5, high rates give an instant response., however optimum rates of inputs in T_4 has given optimum yield.

The effect of different treatments (T_1 ,T_2 ,T_3, T_4, T_5) and use of Guard- cop 93 g/l Cu, in combination with the recommended dose of NPK fertilizer and Cu fertilizer calibrated @ per acre to study different parameters , it was observed that at Control (T_1) the results obtained in all parameters are very low in comparison all other 4 treatments . Interesting comparative observation noted between T_2 & T_3 where Guard- Cop @ 400 ml /Acre solo application over solo Cu-Fert. Broadcast @ 1.5 kg / Acre , LAI was encouraging by 2 % than T_2 , where as yield & karnel plumpness were up by 16.6% & 10% respectively an obvious effect due to better Copper absorbtion , catalysed by Guard-cop spray . Maximum yield benefit has been recorded in combination treatment (T_5) NPK + Cu-Fert. Broadcast + Guard-cop spray , where the Cu absorption effect has been significant in all the parameters ie, yield gone up to 2.92 Mt/Acre, LAI and Kernel Plumpness to 4.89 & 52 respectively were also notable. Other indication of Guard-cop application advantages were observed where Cu deficiency got narrowed down to a significant level in the same field where wheat had consistently given low yield. Better Cu absorption resulted to the better movement of carbohydrates to form starch in the maturing grain head hence the plumpness was increased in T_3 & T_4 significantly , Cu- fert. was added in the experiment schedule to tone up the soil Cu deficiency. However, shrivelled grain, low bushel weight and concentrated protein resulted to low yield figure of 0.75 and 1.2 in T_1 and T_2 respectively. The plumpness result were noted to be better in T_2 – T_5 than very low figure of 15 as observed in T_1 as there

was relatively low starch availability. It was quite significant change noticed in maturity duration by 7 to 12 days between all other treatments (T_3 - to T_5) compared to control , even T_2 was also non-significant which indicates clear influence of Guard-cop .

Fig:6 Effect of Guard-cop on reduction in wheat maturity duration



The recommended rates of Cu are suggested either by broadcast or foliar applications for Wheat (Triticum astivum) grown on organic soils. The broadcast applications suggested are intended to correct deficiencies and should be incorporated before seeding. Foliar applications of Cu are in practice too for effective way to correct Cu deficiency in Wheat (Triticum astivum). The stage of growth at the time of application has a major influence on the effectiveness of the treatment. Observation from this experiment indicate that Guard- Cop application at the tillering stage was the most effective in correcting deficiencies which has a residual effect in other advanced physiological functions .

Table 4 : Effect with Guard-cop on Rust disease (Puccinia graminis f. sp. tritici) by Copper absorption using Copper Hydroxide Fungicide .

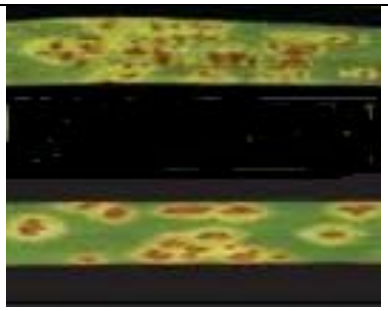
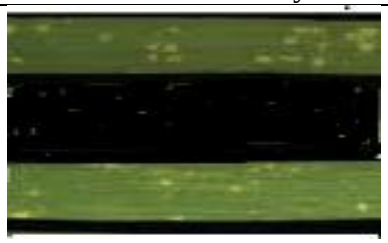
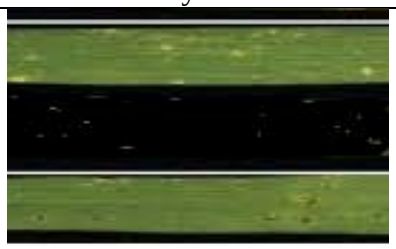
		% Infestation Rust Disease (Puccinia triticina f.sp. tritici)		
Treatment	Treatment Application	Tillering stage	Panicle initiation stage	Milk & boot Stage
T_1	Control	High	High	High
T_2	Kocide	Moderately Low	Moderately Low	Moderately Low
T_3	Guard-cop spray	Moderately Low	Moderately Low	Moderately Low
T_4	Kocide+ Guard-cop spray	Low	Low	NS*
T_5	Cu-Fert.Broadcast+ Kocide+Guard-Cop spray	Very Low	Very Low	NS*

Kocide calibrated @150gms / Acre .and Guard-cop calibrated @ 400ml / Acre

*NS (Non -significant)

Application of Guard- Cop has been recommended as it plays a duel role as broad spectrum fungicidal prophylactic & curative measure and Cu absorption catalyst as well. From the above observation it shows that control plot (T_1) was affected with high infestation of Rust disease (Puccinia triticina f.sp. tritici) but in subsequent treatments T_2 , T_3, T_4 & T_5 , has shown marked improvement where the infestation has been lowered either applying copper Hydroxide as solo or in combination with Guard-cop .

Fig:7 Role of Guard-cop in controlling Rust disease in different treatments as image Observation at Tillering stage shown:

Treatments	Image Observation at Tillering stage
T_1	 High
T_2	 Checked to moderately Low
T_3	 Checked to moderately Low
T_4	 Very Low
T_5	 Non significant (NS)

The Cu absorption plays an essential role in chlorophyll formation , is essential for proper enzyme activity that checked the disease proliferation from Moderately low to very low in tillering stage .
This initial control during tillering has shown significant better results in subsequent stages of panicle initiation to milk & boot stage as well as keeping the causal organism Puccinia triticina f.sp. tritici from low non-significant level which demonstrated natural increasing in the yield.
However blanket application of Copper sulphate as foliar applications can be reduced to avoid direct copper deposition which can act toxic at times .

Advantage of Soil applications of Cu that last for many years , being get attached to the soil organic matter and is not leached down but Cu remain available to plants. But yearly soil testing is advisable the soil test to find Cu range in soil in case it is in high range, annual applications of Cu are not needed.

SUMMARY

Wheat is a copper sensitive crop , Cu is an important nutrient consideration from micro to macro level depending upon its availability in field situation . Recommendation to including Guard-cop in the spray schedule as solo or in combination with copper hydroxide fungicide play catalyst to enhance significantly copper absorption forming a shield gel with its in-built spreading and sticking ability , giving an unique micro-thin cover of copper hydroxide crystals to the plant leaf surface when growing wheat grains on cu deficit soils. The soil test for Cu is an excellent predictor of the need. Broadcast applications incorporated before planting are recommended to correct a Cu deficiency as copper is an important component of proteins found in the enzymes that regulate the rate of many biochemical reactions in plants that affects various parameters as mentioned above with significant reduction in maturity duration. Plants would not grow without the presence of these specific enzymes that promotes seed production and formation , plays an essential role in chlorophyll formation essential for proper enzyme activity .

AKNOWLEGEMENTS :

We express our sincere thanks to the Sri. Sri Prabhat Kumar Singh who has extended his support by allowing us to use a portion of his crop land free of cost as being a progressive farmer he had keen interest to understand new crop management technologies for his own application as well as fellow farmers of his area .

Overwhelming support and excitement from the farming community of Chintamanipur were extended to me and my Technical Supervisor Sri. B.Ghosh during the course of this evaluation. We also express our gratitude to all those from whom we got our various technical information ie Agriculture institutes , Libraries, research scholars Agri-input dealers, company professional etc .

For ABPL INDIA
Research & Development Centre

(Mr. Chatterjee Abhishek)

SCIENTIST

Dated : 14th April'13
Kolkata India