



### From President's Desk



#### COVID-19: decelerating production of agrochemicals, factors for containment, and future prediction in India

##### *The overall scenario and growth rates*

Agrochemicals are the prime elements used in modern-day agriculture for better plant growth. Not all the agrochemicals are eco-friendly. In the previous issue few alternative strategies with stress on the use of biofertilizers and biopesticides, exploring the role of IPM, use of microbial engineering of the available sources, and use of cyanobacteria in plant biology by harvesting the use of sunlight, etc., to cite a few, have been highlighted as emerging areas to reduce over-dependence of conventional agrochemicals for ecological and environmental sustenance. According to the World Health Organization (WHO), it has been estimated that around 20,000 people die yearly due to the effects of the pesticides. Without proper attire and understanding, if the person uses these chemicals in the farmlands, there are high chances of facing severe consequences. Due to this, in many countries the governments have imposed various rules and regulations with regards to the use of harmful chemicals, as they harm the user and the environment as well. The government regulations are, however, considered to be the biggest restraints to the agrochemicals market. The international market of agrochemicals is speculated to earn massive revenue of US\$ 300 billion by the year 2024. This growth is expected to be achieved at a CAGR of 4% between the forecast period of 2019 and 2024, although it is much slower growth rate of 2.6 % at present between 2019-2020. Currently, the low growth is mainly due to economic slowdown across countries owing to the COVID-19 outbreak.

##### *Slow growth rate: breakdown into types of use & factors affecting the production with focus on India*

Internationally, COVID-19 impact on agrochemicals market (<https://www.marketresearchfuture.com/reports/agrochemicals-market-1267>) can be segmented in terms of its type, application mode, type of crop, and demography. To start with product type, the market can be divided into fertilizers, pesticides, and others. To be specific about pesticide, it can again be segmented into herbicides, insecticides, fungicides, and others, and in terms of applications, the international market for agrochemicals can be divided into foliar, fertigation, and others. Based on the type of crop, the global market of agrochemical is divided into cereals, grains, pulses, vegetables, fruits, and others. Thus, the analysis on slowing of growth rate depends on the types of use in the respective region.

Region-wise, Asia-Pacific is the largest region in the global pesticide and other agricultural chemicals market, accounting for 27% of the market in 2019. South America is the second largest region accounting for 24% of the global pesticide and other agricultural chemicals market, and Middle East the smallest region in the global pesticide and other agricultural chemicals market. However, Asia-Pacific is indeed the most dominant of all, with India and China being the leading nations. Japan and Australia have shown great prospect as well in this market segment in recent years.

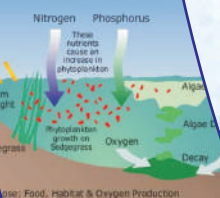
The fertilizer sector has been affected since the outset, primarily in China, the most significant producer and consumer for phosphates, sulphur and sulphuric acid, while going forward it could be

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#### Eutrophication



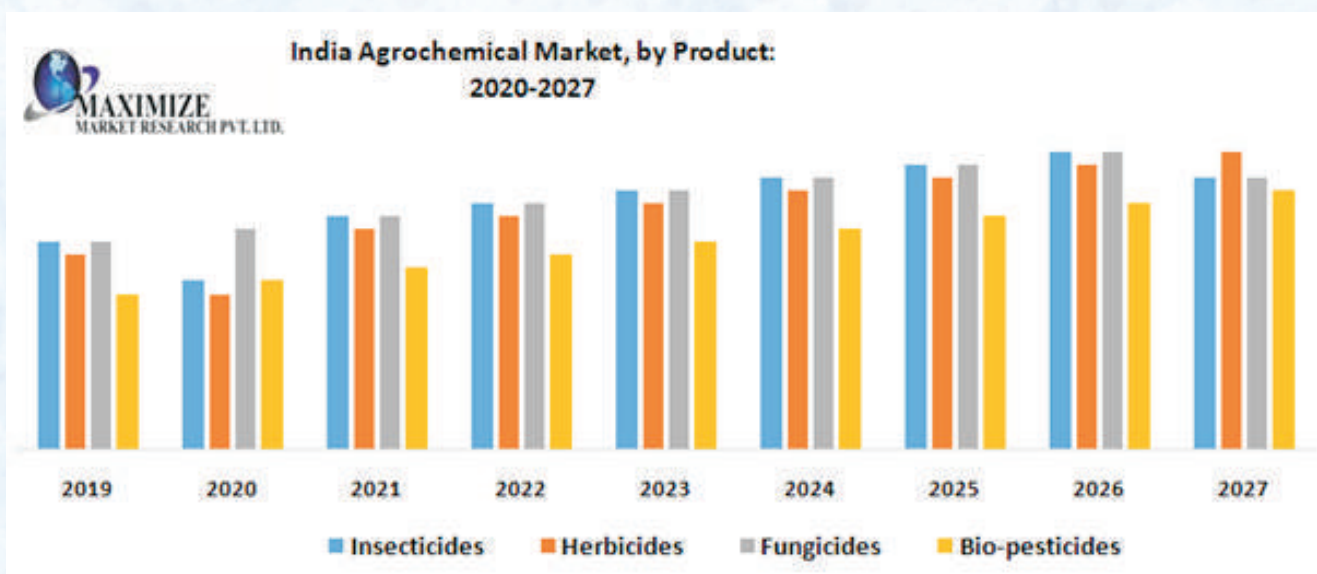


Brazil and India that hit the headlines. It should be remembered that over half the phosphate industry in Hubei was forced to suspend production at the peak of the outbreak in China and there is now concern over how plants in other parts of the globe may weather the crisis and there remains the real possibility of further curtailments in certain regions going forward. Logistical constraints have been the main challenge for all sectors of the industry including India, where it is of major concern for many industries, as a result phosphate plants in the country at one stage already started to shut down. All over, borders are closing, vessels are being quarantined and the movement of people and product is being steadily constrained- including fertilizers and their raw materials. As such further disruption is anticipated in the fertilizer industry across other parts of the globe over the coming months and beyond. In terms of logistics, India however does not rely entirely on trucks, and given the uncertainty due to strategies on restrictions imposed by the government time to time to contain the spread of virus, it instead uses its widespread rail network for the transport of goods far and across. Indian ports have put in place a number of stipulations including strict 14-day quarantine rules for vessels arriving from affected areas. If the virus spreads and a more widespread lockdown is enforced, there will inevitably be some disruption to the movement of fertilizer and raw materials to and from ports and plant. For raw materials the situation remains more complicated with additional moving parts but demand from the fertilizer side is likely to be compromised for the reasons above while supply, if generated from the energy sector, may also see some reduction.

Some plants, including Zuari, RCF and GSFC earlier announced curtailments or closures while many fertilizer plants are taking annual maintenance and therefore any disruption in the coming months could be mitigated accordingly; but if the situation persists beyond foreseeable future, it could affect the future crops. All major ports have been advised to issue force majeure clauses in the event of circumstances preventing loading and discharging of cargo. The fluctuating exchange rate of INR with respect to US\$ and the labour constraints are the additional tantalising factors in the import and transport of goods to affect under the present pandemic situation. This called for government intervention in policy changes for reversing the future trends in India.

### India optimistic for the future

The Government of India is optimistic and encouraging the use of the decontrolled fertilizers, and this along with other new policies launched are the major growth factors to encourage maximum production of fertilizers; while India agrochemical market for the post-COVID-19 era may grow fast with expected CAGR 8 % (<https://www.maximizemarketresearch.com/market-report/india-agrochemical-market/24489/>), but with a word of caution that critical attention on ecological and environmental sustenance needs to be paid to with concomitant increase of conventional uses to suggest strongly more emphasis on biofertilizers and biopesticides, their roles on IPM, use and other areas of research interventions discussed in the previous issue and possibly elsewhere.



**HSSen**  
President



## ARTICLES

## ARTICLE - 1

**Crop and water productivity and intercepted photo-synthetically active radiation of winter maize (*Zea mays* L.) under different irrigation and nitrogen levels**

Maize, worldwide, is one of the major foodgrain for sustenance of human kind as well as animals. Growth and yield of any grain crop under a particular environment are largely determined by radiation interception, the efficiency of conversion of intercepted radiation to dry matter and partitioning of dry matter to grain. Climate change is likely to alter solar radiation worldwide – in some countries it may increase while decrease in others (Wild, 2012). Higher global temperature is going to decrease maize yield due to lower interception of solar radiation with each degree Celsius increase in temperature resulting in diminished maize productivity by 7.4% (Zhao *et al.*, 2017) and hence proper management practice is invoked for optimum canopy management so as to intercept more photosynthetically active radiation (PAR). As such, synergy is needed between environmental factors like effective rainfall, PAR and management practices like irrigation scheduling, fertilizer management, especially nitrogen, to optimize resource utilization while maximizing sustainable productivity. Climate change is altering the precipitation regimes as well which entails that irrigation management has to be astute so as to reduce stress while conserving water resource while increasing water productivity. Deficit irrigation and nutrients create water stress and can reduce radiation interception, efficiency of conversion and partitioning of dry matter to grain. As a result, yield components like ear size, number of kernel per year, the kernel weight of the maize and water productivity are reduced. Nutrient deficiencies also affect intercepted photo-synthetically active radiation (IPAR), crop and water productivity by reducing crop biomass and grain yield. LAI was reduced in crops grown under nitrogen deficiency. An increase in nitrogen concentration at anthesis can result in an increase of LAI and IPAR. Improved biomass, grain yield and water productivity would depend on the capacity to improve the amount of photosynthetically active radiation intercepted by the crop or the efficiency.

Thus, knowledge of resource capture, particularly, soil moisture, nutrients and radiation by crop species under optimum management can be one of the options in improving the productivity of the crop. Keeping the importance of those facts in view, research was conducted to quantify the crop and water productivity of maize as a test crop under different irrigation (120 mm, 180 mm, 240 mm, 300 mm, 360 mm) and nitrogen (30, 60, 90, 120, 150 kg ha<sup>-1</sup>) levels and to study the IPAR at different growth stages of the crop. Water productivity of the crop was quantified under optimum and deficit irrigation regimes with skipping of irrigations at certain growth stages.

Maize composite (cv. Novjyot) was sown in split plot arrangement with 6 irrigation treatments in main plots and 5 nitrogen treatments in sub-plots during two winter crop seasons in Dhenkanal district, Orissa, India (Latitude 28°60' North and Longitude of 85°57' East). The 6 irrigations treatments were phenological based irrigation scheduling (Groot *et al.*, 1986) (I<sub>1</sub> = 120 mm at stage 2, stage 4; I<sub>2</sub> = 180 mm at stage 2, stage 5, stage 6, I<sub>3</sub> = 240 mm at stage 2, stage 4, stage 5, stage 6; I<sub>4</sub> = 300 mm at stage 1, stage 3, stage 4, stage 5, stage 6; I<sub>5</sub> = 300 mm at stage 1, stage 3, stage 4, stage 5, stage 6; I<sub>6</sub> = 360 mm at stage 1, stage 3, stage 4, stage 5, stage 6, stage 7) (Table-1). The nitrogen treatments were: N<sub>1</sub> = 30 kg N ha<sup>-1</sup>, N<sub>2</sub> = 60 kg N ha<sup>-1</sup>, N<sub>3</sub> = 90 kg N ha<sup>-1</sup>; N<sub>4</sub> = 120 kg N ha<sup>-1</sup>; N<sub>5</sub> = 150 kg N ha<sup>-1</sup>. In all cases nitrogen was applied in 3 split doses. The dates of important phenological stages, the leaf area index, above ground biomass, yield and yield components were recorded under different irrigation regimes. The crop was harvested at physiological maturity.

**Phenology and heat units under different irrigation and nitrogen levels**

Climate and irrigations of both growing seasons had no significant effect on these phenological stages. Averaged over years and nitrogen rates, it was found that crop took 49-51 days, 59-60 days, 115-117 days to attain tassel initiation, anthesis and physiological maturity. Nitrogen affects duration of phenological stages significantly. The crop took 48 days to appear tassel in N<sub>1</sub> (30 kg N ha<sup>-1</sup>) to 52 days in N<sub>5</sub> (150 kg ha<sup>-1</sup>). The higher dose of nitrogen (120 kg ha<sup>-1</sup> and above) also enhanced the duration of anthesis stage by 2-3 days. The crop matured in 113-119 days in different nitrogen treatments, took 6-7 more days to mature when higher dose of nitrogen (120 kg N ha<sup>-1</sup> and above) was applied, the difference was statistically significant. Length of the grain-filling period ranged from 43 to 46 days. Thermal time from emergence to anthesis and to maturity did not vary among treatments. Thermal units accumulated from emergence to anthesis ranged from 766 to 805 and from 1587 to 1615 for emergence to physiological maturity.



### Crop productivity under different irrigation and nitrogen levels

An Analysis of Variance (ANOVA) test showed that the mean difference in grain yields among the irrigation and nitrogen treatments were highly significant ( $p < 0.05$ ). In  $I_6$ , highest yield ( $4675 \text{ kg ha}^{-1}$ ) was obtained because in this treatment adequate water was supplied at vegetative, flowering, milk ripe-grain filling stages and satisfied the crop water requirements fully with the amount of irrigation applied along with rainfall, soil moisture contribution from profile. Averaged over nitrogen doses, the grain yield of 2129, 2490, 3553, 3785, 4534 and  $4675 \text{ kg ha}^{-1}$  was obtained in  $I_1, I_2, I_3, I_4, I_5$  and  $I_6$ , respectively. The yield variation occurred mainly due to variation in irrigation and nitrogen doses and nitrogen and water stress significantly affected the number of grain  $\text{m}^2$ , 1000 grain weight (Table-2). Among the irrigation treatments, maximum number of effective grains  $\text{m}^2$  (1870) were produced in  $I_6$  treatment (360 mm), followed by  $I_5$  (1821),  $I_4$  (1545),  $I_3$  (1487),  $I_2$  (1142) and  $I_1$  (1049). Highest 1000 grain weight was found in  $I_6$  (250gm) and minimum 1000 grain weight was recorded in  $I_1$  (203 gm). Study also revealed that water stress before or during flowering and pollination resulted in reduced kernel number ( $I_4$ ) and while stress during or after silking reduced kernel weight ( $I_1$  to  $I_3$ ). Results also showed that year and irrigations effects on harvest index (HI) of maize were non-significant among  $I_1$  to  $I_6$  treatments, the crop had an average harvest index of 33.3, 34.7, 34.1, 34.5, 37.9, and 37.4 % in  $I_1, I_2, I_3, I_4, I_5$  and  $I_6$ , respectively and these variations were statistically non-significant at 5% probability level. The non-significant variation of HI among irrigation treatments might be attributed to the fact that this parameter was not influenced by management practices but it is the characteristics of genotypes. In regards to nitrogen treatments, grain yield was significantly affected by nitrogen application rates except between  $N_4$  and  $N_5$ . Deficit nitrogen created nitrogen stress and grain yield under deficit nitrogen was reduced mainly due to reduction of kernel number and cob size. Like LAI and biomass production, the difference in grain yield was not significant between  $N_4$  ( $120 \text{ kg N ha}^{-1}$ ) and  $N_5$  ( $150 \text{ kg N ha}^{-1}$ ) treatments, which might be attributed to the fact that the grain was not proportionately increased with the amount of additional nitrogen applied.

### Intercepted photosynthetically active radiation (IPAR) under different irrigation and nitrogen levels

Averaged across the years and nitrogen levels, lowest peak intercepted PAR was 66.6% for the  $I_1$  which was statistically significant from IPAR of  $I_2$  (77.0%),  $I_3$  (81.0%),  $I_4$  (85.0%),  $I_5$  (88.0%) and  $I_6$  (89.0%) treatments. The  $I_5$  and  $I_6$  recorded peak IPAR statistically at par. Averaged over irrigation levels, nitrogen rates significantly affected the amount of radiation intercepted. The minimum peak intercepted PAR (67.8 %) was achieved with  $N_1$  ( $30 \text{ kg N ha}^{-1}$ ). The crop with  $N_5$  treatment recorded peak IPAR of 91.2. The increase in IPAR with higher level of irrigations and nitrogen rates was due to better crop growth, which gave maximum plant height, LAI and total dry matter. Study revealed that IPAR was more closely related with the leaf area index and dry biomass in logarithmic relationship with the  $R^2$  value of 0.77 and 0.85, respectively.

### Seasonal crop water use and water productivity

The grain yield along with the depth of irrigation applied, seasonal water use and water productivity of the crop are given in the Table-2. The seasonal crop water use of 251, 307 mm, 358 mm, 412 mm, 405 mm and 459 mm was computed in  $I_1, I_2, I_3, I_4, I_5, I_6$  treatments, respectively. From this study it is revealed that for obtaining optimum yield, irrigation at all the stages are required but by applying adequate water at flowering and milk ripe-grain filling stages and deficit water application at vegetative and late reproductive stage, the yield reduction can be minimized. The water productivity in terms of seasonal crop water use ( $WP_{\text{scwu}}$ ,  $\text{kg m}^{-3}$ ) and net economic return ( $WP_{\text{eco}}$ ,  $\text{Rs m}^{-3}$  or  $\text{\$ m}^{-3}$ ) were computed and pooled data for both the study years are presented in Table-2. Results showed that though yield and net economic returns were the highest in  $I_6$  treatment where 360 mm irrigation water applied but the  $WP_{\text{scwu}}$  was the highest in  $I_5$  where 300 mm irrigation water was applied (including at flowering stage). This may be attributed to the fact that yield was not achieved proportionately in  $I_6$  treatment with amount of additional water applied. Zwart and Bastiaansen (2004) also concluded that the CWP could be significantly increased if irrigation was reduced and crop water deficit was intentionally induced. In our study water productivity (in terms of seasonal crop water use) of 0.849, 0.811, 0.993, 0.918, 1.120,  $1.019 \text{ kg m}^{-3}$  was obtained in  $I_1, I_2, I_3, I_4, I_5$  and  $I_6$  irrigations treatments, respectively. These findings imply that  $84.9, 81.1, 99.3, 91.8, 112.0, 101.9 \text{ kg ha}^{-1}$  maize grain yield was obtained per  $100 \text{ m}^3$  of water used by the crop in different irrigation treatments. The highest water productivity in terms of economic value ( $CWP_{\text{eco}}$ ) was obtained in  $I_5$  plots, varied from  $\text{Rs. } 6.37 \text{ m}^{-3}$  ( $\text{\$ } 0.104 \text{ m}^{-3}$ ) because of higher grain yield and net economic returns per unit volume of water utilized. Lowest  $CWP_{\text{eco}}$  ( $\text{Rs. } 4.65 \text{ m}^{-3}$  or  $\text{\$ } 0.076 \text{ m}^{-3}$ ) was obtained in  $I_1$  plots because of low yield and economic returns per unit volume of water utilized. Nitrogen application rate also significantly affected crop water productivity. The



water productivity of 0.629, 0.742, 0.908, 1.203, 1.239 kg m<sup>-3</sup> was obtained in N<sub>1</sub>, N<sub>2</sub>, N<sub>3</sub>, N<sub>4</sub>, N<sub>5</sub> and N<sub>6</sub> nitrogen treatments, respectively.

A comparison of WP<sub>scwu</sub> between the treatments receiving irrigation at flowering and milk ripe-grain filling stages and not receiving irrigations at these stages with same amount of irrigation (I<sub>4</sub> and I<sub>5</sub>) showed that water was more efficiently utilized when irrigation was not skipped at flowering and milk ripe-grain filling stages. As for example with the same amount of irrigation (300 mm) in I<sub>4</sub> and I<sub>5</sub>, less crop yield was obtained in I<sub>4</sub> because irrigation was skipped at flowering stage of the crop under this treatment. Better water utilization efficiency and higher CWP<sub>scwu</sub> in treatment I<sub>5</sub> were obtained which might be associated with adequate water applied during flowering stage. This result implies that the crop growth stage at which deficit irrigations are imposed on the crop is also a determining factor to achieve higher CWP<sub>scwu</sub>.

### Conclusion

Anthropogenic “undoings” is exacerbating climate change and it will in turn cause scarcity of foodstuff for human and animal by reducing biomass production. Improved biomass depended on the capacity to improve the amount of photosynthetically active radiation intercepted by the crop or the efficiency with which the canopy converts the radiation into biomass (radiation use efficiency) under optimum nitrogen and irrigation regimes. It is concluded that attainment of high LAI that intercepts and converts radiation into dry matter efficiently, and partitioning of the dry matter to the seeds is the major requirement of the latter to attain higher yield. It was also observed that crop water productivity (CWP) can be maximized by withholding irrigation at certain stages under limited irrigation availability that is likely under the regime of climate change because of temporal and spatial variability in rainfall.

**Table-1: Irrigation treatment for the field experiments**

Stages	Description	Irrigation (mm) treatments					
		I <sub>1</sub>	I <sub>2</sub>	I <sub>3</sub>	I <sub>4</sub>	I <sub>5</sub>	I <sub>6</sub>
Stage 0	Period of germination of seed in the soil	X	X	X	X	X	X
Stage 1	Emergence of coleoptile from the soil and seedling growth up to 3 leaves unfolded	X	X	X	60	60	60
Stage 2	Stem elongation (1): Internodes below 5 <sup>th</sup> , 6 <sup>th</sup> , and 7 <sup>th</sup> leaves have begun to elongate	60	60	60	X	X	X
Stage 3	Stem elongation (2): 8 to 11 leaves unfolded, stem elongation rapidly, internodes below 5 <sup>th</sup> and 6 <sup>th</sup> leaves are fully elongated	X	X	X	60	60	60
Stage 4	Stem elongation (3): 12 to 15 or more leaves unfolded, stem still elongates, emergence of tassel from the whorl	60	X	60	60	60	60
Stage 5	Flowering (start of pollen shedding, 50% pollen shedding, 50% silking, end of flowering)	X	60	60	X	60	60
Stage 6	Water ripe stage of caryopsis, start of silk drying	X	60	60	60	60	60
Stage 7	Milk ripe stage (milk to solid conversion of endosperm, but whole kernel content is still milky liquid)	X	X	X	60	X	60
Stage 8	Dry ripe stage (kernel is no longer milky, reached physiological maturity)	X	X	X	X	X	X
Stage 9	Ripeness	X	X	X	X	X	X
	Total irrigation during crop growth (mm)	120	180	240	300	300	360

I<sub>1</sub>, I<sub>2</sub>, I<sub>3</sub>, I<sub>4</sub>, I<sub>5</sub>, I<sub>6</sub> are irrigations treatments; X = No irrigations were applied



Table 2: Water productivity of maize under different irrigation and nitrogen levels

Irrigation treatments	GY (kg ha <sup>-1</sup> )	NR (Rs. ha <sup>-1</sup> )	IWA (mm)	ER + (mm) SPC (mm)	SCWU (mm)	WP <sub>cwu</sub> (kg m <sup>-3</sup> )	WP <sub>nr</sub> (Rs. m <sup>-3</sup> )	WP <sub>\$nr</sub> (\$ m <sup>-3</sup> )
<b>I. Irrigation treatments</b>								
I <sub>1</sub>	<sup>E</sup> 2129	11661	120	131	251	<sup>D</sup> 0.849	<sup>D</sup> 4.65	0.076
I <sub>2</sub>	<sup>D</sup> 2490	14910	180	127	307	<sup>D</sup> 0.811	<sup>C</sup> 4.86	0.080
I <sub>3</sub>	<sup>C</sup> 3553	21977	240	118	358	<sup>B</sup> 0.993	<sup>A</sup> 6.14	0.101
I <sub>4</sub>	<sup>B</sup> 3785	24065	300	112	412	<sup>C</sup> 0.918	<sup>B</sup> 5.84	0.096
I <sub>5</sub>	<sup>A</sup> 4534	25806	300	105	405	<sup>A</sup> 1.120	<sup>A</sup> 6.37	0.104
I <sub>6</sub>	<sup>A</sup> 4675	27075	360	99	459	<sup>B</sup> 1.019	<sup>B</sup> 5.90	0.097
Significance	**					**	**	
<b>Nitrogen levels</b>								
N <sub>1</sub>	<sup>D</sup> 2295	13155	300	114.8	365	<sup>D</sup> 0.629	<sup>C</sup> 3.61	0.059
N <sub>2</sub>	<sup>C</sup> 2714	20526	300	116.8	366	<sup>C</sup> 0.742	<sup>B</sup> 5.61	0.092
N <sub>3</sub>	<sup>B</sup> 3319	19871	300	115.6	366	<sup>B</sup> 0.908	<sup>B</sup> 5.44	0.089
N <sub>4</sub>	<sup>A</sup> 4385	29465	300	114.5	365	<sup>A</sup> 1.203	<sup>A</sup> 8.08	0.133
N <sub>5</sub>	<sup>A</sup> 4525	25725	300	115.5	365	<sup>A</sup> 1.239	<sup>A</sup> 7.04	0.115
Significance	**					**	**	**

Interaction:

Irrigation × Nitrogen: NS

\*\* Significant at 5% probability level, NS = Non significant at 5% probability level

GY = Grain yield; NR = Net return; IWA = Irrigation water applied ER = Effective rainfall; SPC = Soil profile contribution; SCWU = Seasonal crop water productivity; WP<sub>cwu</sub> = Water productivity in terms of crop water use; WP<sub>nr</sub> = Water productivity in terms of net return in rupees; WP<sub>\$nr</sub> = Water productivity in terms of net return in US dollar

I<sub>1</sub>, I<sub>2</sub>, I<sub>3</sub>, I<sub>4</sub>, I<sub>5</sub>, I<sub>6</sub> are irrigations treatments; N<sub>1</sub>, N<sub>2</sub>, N<sub>3</sub>, N<sub>4</sub>, N<sub>5</sub> are nitrogen treatments

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**GourangaKar**

ICAR-Central Research Institute for Jute and Allied Fibres  
Nilgunj, Barrackpore  
West Bengal – 700120, India  
Email: [director.crijaf@icar.gov.in](mailto:director.crijaf@icar.gov.in)  
[crijaf-wb@nic.in](mailto:crijaf-wb@nic.in)



## ARTICLE - 2

### Customized crop-specific water soluble fertilizer formulation for foliar nutrition – A case study with Apple grown in Kashmir valley and Himachal Pradesh

Foliar application of fertilizers can improve leaf turgidity status while increasing the plant's resistance to environmental stresses, hence, foliar nutrient is one of the most commonly used methods to deliver nutrients by spraying water-soluble fertilizers to plant foliage (Zargar *et al.*, 2018). Also foliar application of fertilizers can decelerate the exacerbation of GHG emission due to imbalanced and inordinate granular fertilizer application.

Apple (*Malus pumila* or *Malus domestica*) is the most important temperate pome fruit grown in India in 300 thousand hectares with annual production of 2.33 million tonnes and average productivity of 7.7 tonnes ha<sup>-1</sup> (Anonymous, 2018). Poor nutrient management is one of the key factors responsible for low apple productivity in India. Foliar fertilization has immense potential to be important supplementary strategy for nutrient management in apple.

Penetration of ionic aqueous nutrient solution through leaf cuticular pores (Murtic *et al.*, 2012) and stomata (Fernández and Eichert, 2009) is well established. It further translocate through both symplastic (phloem cytoplasm) and apoplastic (xylem) pathways followed by cell to cell diffusion and active transport through cytoplasmic membrane. Foliar nutrient feeding enjoys advantages of low application rates, uniform distribution, high efficiency of uptake, quick response and effective management of hidden hunger. It is particularly effective when soil conditions limit nutrient availability and plant demand exceeds supply through root. Age, stage and morphology of leaf cuticle, mobility within plant, formulation (nutrient load, solubility, compatibility, concentration and pH) and environmental conditions influence the efficacy to a large extent (Fernández *et al.*, 2013). Success of foliar nutrition strategy depends on identification of critical growth stages and crucial nutrients to be delivered through compatible formulation for effective penetration.

#### **Basic nutrition related facts for apple**

Nutrient removal for high yielding apple orchard is around 110 kg N ha<sup>-1</sup>, 40 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> and 170 kg K<sub>2</sub>O ha<sup>-1</sup> out of which about 20 per cent N, 35 per cent P<sub>2</sub>O<sub>5</sub> and 40% K<sub>2</sub>O gets consumed by the fruit (Nielsen and Nielsen, 2003; Ebert, 2009). Interestingly, Ca uptake is the highest amongst all nutrients which is in the order of 235 kg CaO ha<sup>-1</sup> – out of which only 3 per cent is in matured fruit. The order of nutrient requirement by apple (whole plant) is CaO>K<sub>2</sub>O>N>P<sub>2</sub>O<sub>5</sub>=MgO>S. Among primary nutrients, potassium assumes more importance due to its role in translocation of photosynthates, maintenance of hydrological balance and improving fruit quality. Magnesium deficiency is common in apple growing soils due to leaching of bases. Its deficiency during early growth stages (bud break, petal fall, early fruit development) may limit photosynthesis. Sulphur requirement and uptake is more towards fruit development and maturity stages and almost equally distributed in all plant parts.









Major soil types in apple growing areas of both Kashmir valley and Himachal Pradesh comprise of Brown forest soil (udalf), Grey brown podzol (ustalf) and Alluvial soil (ochrept). The main limiting conditions are high pH (especially in calcareous soils), low to medium soil available P with high P fixing capacity, medium to low soil available K, Ca induced Mg deficiency, Zn and B deficiency. Existing recommendation of soil nutrient application varies considerably in Kashmir and Himachal. While CAN and SSP are main sources of N and P respectively in HP. Kashmir mainly uses traditional sources like urea and DAP. Overall, the nutrient application is higher in HP, though productivity is lesser than Kashmir. Other than micronutrient and calcium chloride, there is no recommendation of foliar fertilisers by either of the Government sources.

#### **Foliar nutrition in apple – existing knowledge**

##### **Physiological growth stages of apple**

Since main strategy for developing foliar nutrition product is to address the issue of hidden hunger at most critical growth stage, it is important to understand the physiological stages of the target crop. After winter both flower and leaf buds break their dormancy. The stage of 'Bud burst' is further progressed as 'Silver tip' and 'Green tip'. The leaf bud develops into 'Half-inch green' and then forms 'Tight cluster' of leaves with flower buds (white in colour initially) at centre. 'Pink bud' appears on further development of flower bud which is also referred to as 'pre-bloom stage'. From 'Pink bud' to 'Full bloom' it takes about seven days and another week for 'Petal fall' to denote starting of 'Fruit set'. The 'Fruit growth' stage continues for about 2 to 3 months (depending on altitude) followed by 'Fruit filling' stage for another 1 to 1½ month. The fruit attains its maximum weight, colour, specific gravity, and total soluble solids (TSS) at maturity. The post-harvest period may extend for another two months during which the plant goes under rest before entering dormancy at snowfall where primordia for leaf and flower buds undergo slow physiological development inside plant.



							
Bud burst	Tight cluster	Pink bud	Petal fall	Fruit set	Fruit growth	Fruit filling and maturity	Post harvest
J&K Feb/Mar	Feb/Mar	Mar/April	April/May	April/May	July/Aug	Aug/Sept	Sept/Oct
HP Jan/Feb	Jan/Feb	Feb/Mar	Mar/April	Mar/April	June/July	July/Aug	Aug/Sept

**Figure 1. Critical growth stages of full bearing apple trees and their occurrence in J&K and HP**

### Response to foliar fertilization in apple

Several studies available on response to foliar feeding of primary and secondary nutrients, micronutrients and growth promoting substances in apple mostly under high yielding conditions outside India ([www.spectrumanalytic.com](http://www.spectrumanalytic.com); Shahin *et al.*, 2010; Murtic *et al.*, 2012; New England Tree Fruit Management Guide, 2015-16). After a thorough analysis of existing knowledge, the following three distinct trends of response were identified.

1. During tight cluster to pink bud stage application of Urea @ 0.35 to 0.4 per cent, Di-sodium octa-borate (water soluble boron source, 20% B) @ 0.065 to 0.13 per cent and Zn sulphate/ Zn EDTA @ 0.45 / 0.25 per cent respectively helped in overcoming winter-injury of buds, improved early season tree growth, increased effective pollination period through improvement in pollen germination and pollen tube growth and improved fruit setting.
2. During petal fall to early fruit development stage (post-bloom stage) 2 to 3 rounds of application of 0.75 to 1 per cent solution of both K nitrate and Mg sulphate along with 0.065 to 0.13 per cent Di-sodium octaborate and 0.25 per cent Zn EDTA improved leaf lamina area and leaf colour, fruit size, fruit yield, fruit colour and resistance to diseases. Some workers also reported prevention of drought spot, cracking of fruit, internal corking, die-back and premature fruit ripening. Excess application of K nitrate was reported to induce Mg deficiency. Use of Algan (sea-weed extract) @ 0.2 per cent and Gibberellic acid @ 20 ppm improved fruit yield, fruit size and colour.
3. During late maturity stage (1½ to 1 month before harvest) use of calcium chloride @ 0.3 to 0.5 per cent solution (2 rounds of application) has widely been reported to improve colour and reduce bitter pit, cork spot and senescent breakdown during storage.

All the nutrient solutions were usually applied @ 10 litres per full grown tree. Response data indicates that intervention during early fruit setting stage gives maximum benefit in terms of yield and yield attributing parameters. Absence of any structured recommendation of foliar fertilization during early fruit growth stage offers a unique opportunity of value addition for apple growers in India. Role of K, S, Mg, Ca, Zn and B emerges important at this stage.

### Customized foliar nutrition product for apple and its efficacy

#### Formulations and Experimental Treatments

Two possible formulations were developed based on studies related to nutrient uptake dynamics, knowledge on past response study, soil fertility status and possible roles of the nutrients at critical growth stage of 'early fruit development'. These are:

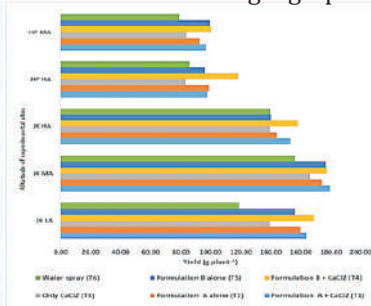
- Formulation A : 18:12:5:0.4:0.3:0.5::K<sub>2</sub>O:S:Mg:Ca:Zn:B and
- Formulation B : 16:11:5:0.3:0.3:0.4::K<sub>2</sub>O:S:Mg:Ca:Zn:B (enriched with growth promoting factors)

Both the formulations were sprayed on leaf and developing fruits, at pre-decided growth stages of 15, 30 and 45 days after petal fall @ 10 litres of 1% solution on each fully grown and bearing tree. Both the formulations were applied with and without additional foliar application of Ca-chloride @ 5 kg ha<sup>-1</sup> spray<sup>1</sup>; two sprays at 1½ and 1 month before harvest. Benchmark practice of only CaCl<sub>2</sub> spray and control (water spray) were kept as checks. All cultural practices (other than foliar nutrient application) including the soil nutrient application and pest/ disease control were kept uniform in all the experimental trees. Studies were conducted in Kashmir at Aliyalpora, Pulwama (low altitude, LA); Batpora, Hygam (medium altitude, MA); Budgam, and Shopian (high altitude, HA). In Himachal Pradesh the sites were Rohru, Shimla (MA), Sarog, Thanedarin Shimla and Jubbalin Kinnaur districts (all HA).



### Apple yield and fruit quality

The figure below represents compiled yield data in both the geographic locations at various altitudes of growing conditions:



**Figure 2. Yield of apple trees in J&K and HP as influenced by Application of different formulations of foliar nutrients**

Maximum yield was obtained with Formulation B (along with benchmark practice of CaCl<sub>2</sub>) irrespective of altitudes and locations. Extent of yield increase over control (water spray produced least fruit yield across locations and altitudes) was in the range of 13 to 41 percent and over benchmark (only CaCl<sub>2</sub> application) 7 to 42 per cent, clearly establishing crop response to the innovative formulation. Sole responses improved when CaCl<sub>2</sub> was added to the schedule near maturity stage – in either of the two formulations. Formulation B was significantly better than Formulation A and data trend was similar across the locations, altitudes and years of operation. Fruit dimensions (length, breadth, average fruit weight etc.) largely followed the yield pattern since these are considered important yield attributing parameters for apple.

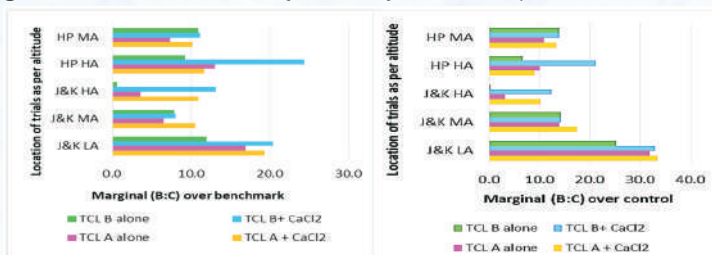
**Table 1. Effect of treatments on quality parameters of apple (data in a column sharing any common letter in superscript are not significantly different)**

Treatments	TSS (%)		Acidity (%)		Reducing sugars (%)		Total sugars (%)		Ascorbic acid (mg 100g <sup>-1</sup> )	
	LA	HA	LA	HA	LA	HA	LA	HA	LA	HA
Formulation A + CaCl <sub>2</sub>	15.5 <sup>a</sup>	14.7 <sup>a</sup>	0.08 <sup>c</sup>	0.09	6.56 <sup>a</sup>	5.9 <sup>ab</sup>	11.31 <sup>b</sup>	10.2 <sup>b</sup>	49.4 <sup>b</sup>	55.5 <sup>b</sup>
Formulation A alone	12.0 <sup>c</sup>	12.7 <sup>bc</sup>	0.11 <sup>b</sup>	0.10	5.85 <sup>b</sup>	5.5 <sup>bc</sup>	9.02 <sup>e</sup>	8.9 <sup>c</sup>	56.6 <sup>a</sup>	63.8 <sup>a</sup>
Only CaCl <sub>2</sub> (benchmark)	13.0 <sup>b</sup>	12.8 <sup>bc</sup>	0.10 <sup>b</sup>	0.10	5.79 <sup>b</sup>	5.4 <sup>bc</sup>	10.35 <sup>d</sup>	9.4 <sup>c</sup>	39.5 <sup>c</sup>	47.4 <sup>c</sup>
Formulation B + CaCl <sub>2</sub>	16.1 <sup>a</sup>	15.4 <sup>a</sup>	0.08 <sup>c</sup>	0.08	6.63 <sup>a</sup>	6.2 <sup>a</sup>	11.92 <sup>a</sup>	10.9 <sup>a</sup>	49.5 <sup>b</sup>	53.8 <sup>bc</sup>
Formulation B alone	13.5 <sup>b</sup>	13.0 <sup>b</sup>	0.10 <sup>b</sup>	0.10	6.01 <sup>b</sup>	5.4 <sup>bc</sup>	10.83 <sup>c</sup>	9.2 <sup>cd</sup>	38.9 <sup>c</sup>	49.3 <sup>bc</sup>
Water spray (control)	11.4 <sup>c</sup>	11.9 <sup>c</sup>	0.12 <sup>a</sup>	0.11	5.20 <sup>c</sup>	5.1 <sup>c</sup>	8.20 <sup>f</sup>	8.7 <sup>d</sup>	38.4 <sup>c</sup>	36.6 <sup>d</sup>
CD(P = 0.05)	0.7	0.9	0.01	NS	0.42	0.6	0.27	0.5	5.7	7.1

Data presented in Table 1 indicate that both the formulations (A and B) were equally effective in improving the quality parameters of apple when applied along with CaCl<sub>2</sub> at respective stages and scored significantly better than both benchmark and control. It also signifies improvement in both human nutrition value and customers' preference. As per the known physiological roles, K, S and B might have played a significant role in improving the quality with Ca having synergistic role. A blind test was conducted near harvest stage and the ranking per visual perception by experienced apple growers established value proposition through formulation B (along with CaCl<sub>2</sub> application near maturity).

### Financial benefits

Since adoption of any product/ technology is largely driven by its potential capacity to improve farm income; net benefit (₹ per tree or acre) and marginal benefit to cost ratio (B:C ratio) remain major drivers.



**Figure 3. Marginal B:C ratio over both control and benchmark treatments**



As data suggest, rate of return was found to be higher in Kashmir valley condition than HP. Formulation B along with  $\text{CaCl}_2$  application gave maximum rate of return; the B:C ratio over control ranged from 12 to 33 while it ranged from 8 to 24 over benchmark practice. In J&K the rate of return reduced with altitude indicating further need for optimizing dose at high altitude conditions. In HP, the higher altitude locations gave high return after dose optimization.

### Conclusion

The overall analysis clearly indicates that foliar application of Formulation B (16:11:5:0.3:0.3:0.4 ::  $\text{K}_2\text{O}:\text{S}:\text{Mg}:\text{Ca}:\text{Zn}:\text{B}$ , enriched with growth promoting factors) three times during fruit development stage starting from 15 days after petal fall with remaining sprays spaced at 15 days interval along with calcium chloride during fruit maturity stage (2 sprays at 30 and 15 days before harvest) gives best overall performance and thus to be recommended for apple growers of both J&K and HP. While the rate of application during each spray should be  $100 \text{ g plant}^{-1}$  through 10 litre solution in J&K; the application rate may be reduced to  $75 \text{ g plant}^{-1}$  in Himachal Pradesh. On the basis of the results described above, TCL obtained FCO approval for the gradevide Gazette Notification No. SO 2970 (E) dated 25<sup>th</sup> November, 2014. It is the first ever Water Soluble Customized Fertiliser approved in India, and eventually was commercialized under trade name of 'Tata Paras Formula – Foliar Apple'; till it exited the fertiliser business. Rallis India Ltd., a subsidiary of Tata Chemicals Ltd., has further improved the product and is set to commercialize as 'Aquafert Foliar Apple' in Q4 of 2020-21.

### Acknowledgement

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**SubhenduBhadraray**

Rallis Innovation Chemistry Hub, Rallis India Limited (A Tata Enterprise),  
Srigandhanagar, Peenya, Bangalore 560059  
E mail: [subhendu.bhadraray@rallis.co.in](mailto:subhendu.bhadraray@rallis.co.in)



### ARTICLE - 3

#### Agriculture and Fertiliser - Saviour in the COVID-19 hit Economy

The Novel Coronavirus COVID-19 is a global threat causing unprecedented fear, uncertainty, large-scale disruption, a sense of emergency everywhere keeping people restricted and confined at home to prevent the virus spread with consequent huge knock on economy and interestingly agriculture is at the front and centre of the news. Despite facing huge challenges, our farmers and agricultural value chain workers have kept the supply chain working from farm to fork for agricultural produces. Similarly, the vendors enabling factory to farm services operational for agri-inputs like fertiliser worked on war footing for keeping supply of food continued to the common people and economy rolling. Fertiliser and agriculture have boosted the moral of rural India during this tough time with the intervention of the Government in improving liquidity of farmers through various measures. Lessons from the Corona pandemic need to be utilised in strengthening agriculture for making self-reliant development with sound implementable plans and suitable investments.

#### Fertilizer and Agriculture

According to the United Nations (UN), the global population is expected to reach 9.2 billion by 2050 and accordingly we have to grow food to eliminate hunger. This requires increase in food production per unit available arable land and other scarce resources by ecological intensification, the goal of which is to approach to “attainable yield” of farming systems with minimal or no negative environmental impact. The world will not be able to meet its food production goals without depending on biotechnology and improved genetics, and of course without fertilizer. Chemical fertilizer is the key factor for 40 to 60% of the world's food production. It is difficult to determine exactly how much crop yield is due to the use of chemical fertilizer beside other factors like inherent soil fertility, climatic conditions, crop rotations, management and the crop itself but it is a proven fact that fertilizers with crop and site specific nutritional proportion and quantity adopting integrated nutrient management is essential to maintain crop productivity at existing levels and will be even more crucial if yields are to be increased in the backdrop of increasing food demand to feed the ever increasing population. Thus, the issue of fertiliser is a very important and integral part of agriculture.

#### Sufferings of farmers during COVID19 Pandemic

The economic impact of the 2020 corona virus pandemic in India has been largely disruptive magnifying the pre-existing risks to India's economic outlook. Under complete lockdown, more than 50% of businesses in the country were projected as significantly affected where supply chains have been put under stress with the lockdown restrictions where daily wage labourers are at most risk. Many Indian companies had either to temporarily suspend or significantly reduce operations while many young start-ups were severely impacted due to restricted funding. Lockdown started from 24<sup>th</sup> March during the harvesting season of rabi crops. As farm produces are perishable in nature, large number of farmers throughout the country faced huge uncertainty where problem was aggravated due to shortage of labour in one hand and distress sale at throw away price on the other as a result of closing of restaurants, hotels and dhabas. Fruits, vegetables, flowers, poultry and milk producers were the worst sufferer.

#### Fertilizer sale scenario

At macro level, the data from the Department of Fertilizers shows all-India nutrient sales in March 2020, during which lockdown started, registered overall growth of 17.7% from 24.6lakh metric ton (LMT) in March 2019 to 28.96 LMT in March 2020 which dropped to 20.56 LMT during April 2020 as against 14.17 LMT in April 2019 with 45.1% growth which was due to 36.2 per cent for urea (10.95 LMT versus 8.04 LMT in April 2019), 71.7 per cent for DAP (2.97 LMT versus 1.73 LMT), 81.4 per cent for N-P-K-S complex fertilizers (3.9 LMT versus 2.15 LMT), 43 per cent for MOP (1.33 LMT versus 0.93 LMT), 5.6 per cent for SSP (1.31 LMT versus 1.24 LMT) and 37.5 per cent for compost (0.11 LMT versus 0.08 LMT).

**Table 1. Fertilizer sale scenario (All India)**

Period	2018-19	2019-20	Growth (%)
March	24.60	28.96	17.72
April	14.17	20.56	45.10
May	20.24	40.02	97.73
April-June	111.61	61.05	82.81

Reason of March-April 2020 growth might be due to the more area coverage under rabi crops as a result of extended monsoon leading to recharged groundwater tables with filled reservoirs leading to more demand of fertilizers for bumper crop. Retail sales of fertiliser have surged by almost 98 per cent year-on-year in May 2020. During April-June 2020, the retail point of sale (POS) of fertilizers to farmers was 111.61 lakh tonnes which is 82.81 per cent higher than



the last year's sale of 61.05 lakh tonnes during the same period.

Lockdown has clearly not impacted nutrient sales partly because of agricultural inputs being exempted from any movement/ distribution/ retailing restrictions. The momentum behind sales of urea, DAP, NPK, MOP and SSP fertilizers in India has been primarily driven by increased crop acreage and solid expectations for the on-going monsoon after the IMD forecast of rainfall for the country during the four-month (June-September) season to be 102% of the 'normal' monsoon coupled with the panic buying since dealers wanted to stock up in anticipation of enough kharif demand. Normally retail sale of fertilizers mostly takes place on credit and the credit period extends to 75-90 days for April sales, 45-60 days for May sales, 15-30 days for June sales, and that of 10-15 days in July as the kharif cropping season progresses. But this time, farmers purchased mostly in cash which indicates good uptake down the line from retailers. Also, there were worries that the weakening of the rupee may lead to higher prices of imported fertilizers in near future.

To analyse the fertilizer sale dynamics more closely, a micro level pilot study was conducted involving 2 wholesalers, 2 retailers and a reputed Cooperative sale points of Murshidabad district of West Bengal in connection with sale of fertilizers and the net profit earned during this lockdown period so far and it has been found that almost all the sale points have sold marginally more fertilizers during April-July 2020 as against the corresponding period of 2019 but the extra profit earned this time has been very substantial. According to sellers, profit was more due to better liquidity and better demand of inputs from farmers which has primarily been due to good farm gate price of potato, better selling of paddy at MSP (Rs. 1815.00 per quintal), early onset of monsoon and exemption of farm related activities from lockdown restrictions.

**Table 2. Comparison of sale of fertilizers and profit by the wholesalers and retailers during 2019 and 2020**

Sl. No.	Type of Sellers	Name of the Sellers	Sale Value (Rs. in lakh)		Net Profit (Rs. in lakh)	
			March-July 2020	March-July 2019	March-July 2020	March-July 2019
1	Wholesaler	Firoz Ali	430	415	8.3	7.52
2	Wholesaler	Nure Alam Dewan	128	131	5.49	5.31
		<b>Average</b>	<b>279</b>	<b>273</b>	<b>6.89</b>	<b>6.41</b>
3	Retailer	Sanat Pal	54	46	1.2	0.9
4	Retailer	Shib Durga Fertilizers	9.5	9.0	0.5	0.35
		<b>Average</b>	<b>31.75</b>	<b>27.5</b>	<b>0.85</b>	<b>0.62</b>
5	Cooperative	Paschim Talibpur SKUS	34	30	0.75	0.60

Fertilizer purchases are also seen to be driven by and linked with liquidity with farmers with the total money pumped in through government grain procurement at the MSP, distribution of grains under the PM Garib Kalyan Yojana (PMGKY), the Rs. 2,000.00 first-instalment direct cash transfer to farmers under the Pradhan Mantri Kisan Samman Nidhi scheme, the 100days MGNREGA work etc. during post March 24 lockdown. That liquidity has in turn got re-invested in buying fertilisers and other farm inputs.

#### **Fertilizer and Agriculture as shock absorber**

Farmer knows very well that he can reap a good harvest and earn profit if he uses fertilizers efficiently and effectively. So, the most important thing at the end of the day is that even during pandemic the farmer wanted fertilizer. There is certainly no shortage of demand here which might not be so with cars, two-wheelers, other organised sectors and of course many unorganised sectors of economy. A micro level entrepreneurial survey was conducted involving few vendors with non-agri micro enterprises like pavement stall, snack stall, barber shop, motor garage, cobbler who had to close or /suspend their business and became jobless during pandemic as is evident from the table. The agriculture & allied sectors acted as shock absorber giving them breathing space providing with alternate entrepreneurial means on road ensuring a sizable income to live and earn their livelihood which helped them enabling food access and support to the needy people who were otherwise compelled to remain in their house under lockdown.

**Table 3. Change in Income of vendors due to change in livelihood support as a result of Covid-19 pandemic**

Sl No.	Name of Vendor	Original Business	Av. Income /day (Rs)	Changed Business	Av. Income /day (Rs)
1	Samir Pal	Pavement Stall (garments)	800	Moving vegetable vendor on roads	400
2	Paresh Das	Snack Stall	400	Moving vegetable vendor on roads	300
3	Prasenjit Ghosh	Barber	300	Moving fish vendor on roads	300
4	Firoj Sekh	Motor Mechanic	500	Moving fruit vendor on roads	500
5	Prasad Kumar	Cobbler	500	Moving chicken vendor on roads	400



### Conclusion

When common people across the country are within their home or a poor migrant worker walking along the street, common points are that we need food as basic human necessity. Fertilizer driven sustainable agriculture can ensure food security and also extend lifesaving earning support to millions of jobless people. This trying time of Covid-19 has once again proved that agriculture is the main stay of our economy.

Due to unemployment and lack of earning opportunity, many people from rural India move to urban areas and the reverse migration of labourers during Covid-19 pandemic unfolded the truth that the urban centric development measures could not absorb migrant rural workforce suitably providing adequate shelter and food. It is expected that the economists will not only advocate for promoting the industrial sectors in coming days but also will simultaneously give agriculture and fertiliser industry a proper impetus in policy making ensuring substantial public sector investment because the agriculture sector employs more than 50% of total workforce in the country and emerged as a healer and saviour of economy in this tough times. With agriculture emerging as the strong pillar of economy during this pandemic, it has to be kept in mind that marginalising farming in future will be suicidal and instead it needs a total revamp with utmost care and huge investment.

**PSBhattacharya<sup>1</sup> and UrjashiBhattacharya<sup>2</sup>**

<sup>1</sup>Indian Farmers Fertiliser Cooperative Limited, Kolkata, W.B.

<sup>2</sup>Bidhan Chandra Krishi Viswavidyalaya, MOhanpur, Nadia, W.B.

Email of corresponding author: [parthaiffco@gmail.com](mailto:parthaiffco@gmail.com)

### HONOURS & AWARDS



Dr. Prithusayak Mondal, Assistant Professor in Biochemistry, Regional Research Station (Terai Zone), Uttar Banga Krishi Vishwavidyalaya, Pundibari and Life Member of SFE received the YOUNG ACHIEVER AWARD 2020 of the Institute of Scholars (An ISO 9001:2015 Certified Professional Organization registered under Ministry of MSME, Govt. of India) for publishing an outstanding paper entitled as "Azomethine based nano-chemicals: Development, in vitro and in vivo fungicidal evaluation against *Sclerotium rolfsii*, *Rhizoctonia bataticola* and *Rhizoctonia solani*" in the Journal 'Bioorganic Chemistry'

Dr. Lakshman Chandra Patel, Assistant Professor, College of Agriculture, Bidhan Chandra Krishi Viswavidyalaya, Burdwan sadar and Life Member of SFE received the Young Scientist Award (2020) of Agro Environmental Development Society (AEDS), Uttar Pradesh and the Fellow Award (2020) of Society for Biotic and Environmental Research (SBER), Khowai, Tripura for his contributions in the field of Agricultural Entomology.

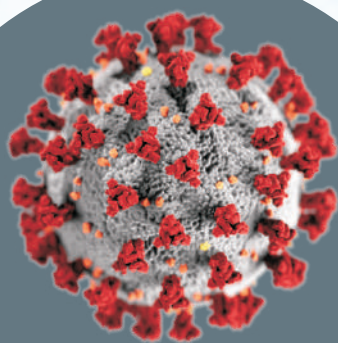


Dr. Dipak Ranjan Biswas, Principal Scientist, Division of Soil Science and Agricultural Chemistry, ICAR-IARI, New Delhi and Life Member of SFE has been elected as the President, Agriculture and Forestry Sciences Section, 108<sup>th</sup> Session of the Indian Science Congress, 2020-2021.



“As crude a weapon as the cave man's club, the chemical barrage has been hurled against the fabric of life - a fabric on the one hand delicate and destructible, on the other miraculously tough and resilient, and capable of striking back in unexpected ways. These extraordinary capacities of life have been ignored by the practitioners of chemical control who have brought to their task no "high-minded orientation," no humility before the vast forces with which they tamper.”

— **Rachel Carson, Silent Spring**



- \* Maintain Social Distancing in Agricultural Operation.
- \* Wear Mask & Frequent Hand washing.
- \* Stop spread of Covid-19 Virus.

**Stay HOME**  
**Stay SAFE**

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**Contact:**

Prof. Biswapati Mandal,  
[mandalbiswapati@rediffmail.com](mailto:mandalbiswapati@rediffmail.com),  
Ph. No. 9433533598

Dr. H. S. Sen, Email: [hssen.india@gmail.com](mailto:hssen.india@gmail.com),  
[hssen2000@hotmail.com](mailto:hssen2000@hotmail.com), Ph. 9874189762

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