https://doi.org/10.29321/MAJ.10.A02431

*Madras Agric J* 71 (1) 25-31 January 1984

# UPTAKE OF ZINC BY DIFFERENT VARIETIES OF WHEAT AS INFLUENCED BY ZINC CARRIERS IN CALCAREIOUS SOIL

N.P. SINHA, R. SINGH & B. PRASAD*

Efficacy of different zinc carriers on growth and yield of different germplasm of wheat and their zinc uptake were studied by conducting pot experiments in calcareous soils of North Bihar. The wheat varieties according to their yield potential followed the trend as Kalyan Sona> H.D 1982> HP 1102> HO 1553> Sonalika. Response of different Zn carriers followed the following trend in production of wheat grain and straw as $ZnSO_4$ .$ZnCl_2$= ZnO> $Zn_3(PO_4)_2$> $ZnCO_3$. The differential uptake of Zn by different varieties of wheat could be arranged as $ZnSO_4$> $ZnCl_2$> ZnO> $Zn_3$ $(PO_4)_2$> $ZnCO_3$. All the Zn carriers at higher levels of Zn application gave significantly greater uptake of Zn.

Studies on direct and residual effect of Zn fertilizer on the uptake by the crops have been shown to be helful in economising on its use without adversely affecting soil fertility and crop yield. Differential response of crop varieties to zinc fertilisation have been reported by several workers including Shukla and Raj (1976). The present investigation was carried out to study the comparative efficacy of different carriers of Zn on the yield of wheat crop and its residual effect on succeeding crops in intensive cropping on calcareous soil.

## MATERIAL AND METHODS

The present investigation was carried out with five differant germplasm of moong (pusa Baishakhi, PS 16, G 95, HP 28 and S 8), maize (GS 2, GS 4, GS 5, Vijay and Hi-starch) and wheet (HD 1553, HD1982, Sonalika, HP 1102aud Kalyan Sona) towards application of different carriers of zinc. Pot experiments with above varieties ($V_1$, $V_2$, $V_3$, $V_4$ and $V_5$) on the calcareous soils of North Bihar were conducted for three years in 1976-77,1977-78 and 1978-79. The initial physical and chemical properties of calcareous soils selected for this study was loam (53.22 33.20 and 20,6% sand, silt and clay respectively) having pH 8.4, organic carbon 0 36%, calcium carbonate 34.2%, total N 0 038%, AV. P. 12.6 Kg/ha, av. K 175. 0Kg/ha and av. Zn 0.6 ppm.

The experiment was conducted with 5 kg of soil in earthen pots of 12 '' diameter coated with coaltar and lined with alkathene which was already washed with 0.1 N HCl and then finally washed with deminoralised water. The experiment had eleven treatments as shown below, with three replications

*Present address : Patna Campus, P.O, Sheikhpura Farm. Patna-800014.
Rajendra Agricultural University, Dholi Campus Muzaffarpur,

$T_1$-Control, $T_2$-2.5 ppm Zn as $ZnSO_4$. $7H_2O$, $T_3$-5 ppm Zn as $ZnSO_4$. $7H_2O$, $T_4$-2.5 ppm Zn as $ZnCl_2$, $T_5$-5 ppm Zn as $ZnCl_2$, $T_6$-2.5 ppm Zn as ZnO, $T_7$-5 ppm Zn as ZnO, $T_8$-2.5 ppm as Zn as $ZnCO_3$, $T_9$-5 ppm Zn as $ZnCO_3$, $T_{10}$-2.5 ppm Zn as $Zn_3(PO_4)_2$, $T_{11}$-5 ppm Zn as $Zn_3(Po_4)_2$. Different Zinc carriers were applied in solid form before sowing the seeds. Zinc was applied only initially to the first crop and then only its residual effect was studied in subsequent crops. The rate of N:$P_2$K application were for moong 20:60:40 ppm, maize 100:60:40 ppm, wheat 100:60:40 ppm. In maize and wheat 50% of the nitrogen was applied at the time by sowing and rest 50% was applied as top dressing in two split doses but in moong all the nitrogen was applied at the time of sowing. In all the crops P and K were applied at the time of sowing. N, P and K were applied every time for each crop in the form of urea, potassium hydrogen phos phate and potassium chloride, respectively. All the pots were irrigated to make the soil of each pot for the optimum germination of seeds. Eight seeds of different varieties of crop were sown separately in each pot, and thined to five after ten days. Moong crop was followed by maize which was followed by wheat in each year in each pot. The same nucleus seeds of each crop were used in the same pot in different years to study the residual effect of different fertilizer. Domineralised water was used for irrigation. Interculturing and irrigation were done as and when required. The maize plants were harvested after fifty days of sowing and moong and wheat after maturity of the crops. In this paper only the performance of wheat crop and Zn uptake is reported. Initial soil samples were analyzed as per standard methods described by Jackson (1967). The grain and straw were prepared for analysis and Zn contents were determined in triacid extract (wet oxidation method)by atomic absorption spectrophotometer (Jackson, 1967).

## RESULTS AND DISCUSSION

*Grain and straw yield:* It is evident from Table 1 and $ZnSO_4$ recorded the highest grain yield during all the three years and proved significantly superior to all the other sources of Zn. $ZnCl_2$ and ZnO were at par but significantly outyielded both $ZnCO_3$ and $Zn_3(Bo_4)_2$ in all the three seasons, where as $Zn_3(PO_4)_2$ had recorded significantly higher yield than $ZnCO_3$. In the first year 1976-77 $ZnSO_4$ gave 9.7% extra yield over $ZnCl_2$ and 11.9% extra yield over ZnO and 20.7% over $Zn_3(PO_4)_2$ and 29% over $ZnCO_3$. In second and third years (1977-78 and 1978-79) $ZnSO_4$ gave 6 8% and 7.7% extra yield over $ZnCl_2$, 9 4% and 8.2% extra yield over ZnO, 19.2% and 18.7% over $Zn_3(PO_4)_2$ and 27.7% and 26.8% over $ZnCO_3$. The different sources of zinc responded in the following order: $ZnSO_4$, $ZnCl_2$=ZnO $Zn_3(PO_4)_2$, $ZnCO_3$. Among the varieties Kalyan Sona gave the highest yield (5.42 gm/plt) in all the three years (Table 2). In first year (1976-77) there was no significant difference between the yields of Kalyan sona, HP 1102, and HD 1982 but Kalyansona and HD 1982 proved superior to HD 1553 and Sonalika HD 1102 gave significantly

higher yield than Sonalika while HD 1553 and sonalika were at par. In second year (1977-78) Kalyan sona significantly outyielded all the varieties except HD 1982 which was at par with HP 1102. Yield differences between HP 1102, Sonalika and HD 1553 were nonsignificant. During third year (1978-79) Kalyan sona proved to be superior to all other varieties. Varieties HD 1982, Sonalika and HP 1102 did not differ significantly among themselves during the year 1978-79. Kalyan sona gave highest yield due to application of zinc and the next in order was HD 1982, which was followed by HP 1102 and HD 1553, the lowest response of zinc application was observed in variety sonalika. Both the higher and lower doses of zinc significantly increased the grain yield of wheat in all the three years (Table 3). Higher dose (5.0 ppm) proved to be significantly superior to the lower dose (2.5 ppm). The yield of wheat grain with application of 5 ppm zinc increased by 12.8% over 2.5 ppm and by 65.0% over control in 1976-77. In 1977-82 and 1978-79 also 11.2% and 11.6% yield was increased by 5 ppm dose over 2.5 ppm and 54.3% and 30.1% over no zinc application. It is evident from the above tables that the similar trends were obvious in the case of straw yield. The performance of ZnCl was at par with ZnO. This may probaly be due to partial solubility of ZnO and it may be also due to root excudate liberated by wheat crop and these need further study. Kalyan sona gave the highest yield in all the three years this may be due to genetic variation and availability of different germplasm of wheat to absorb the amount of zinc from applied fertilizers

*Zn Concentration In Grain And Straw :*

Pooled data of three years of Zn content in grain and straw are presented in Table 4 it is evident from Table 4 that with the application of Zn, its content in grain and straw increased significantly in all the varieties with respect to variety, source, dose and control versus rest were found to be highly significant. Variety Kalyan sona contained highest zinc (89.5 ppm) but HD 1553 has lowest value (84.0 ppm). Zinc content of variety HD 1982 and Kalyan sona was observed at par but variety HD 1982 and Kalyan sona contained significantly higher than HD 1553, Sonalika and HP 1102. It was also observed that HD 1553 contained (84 ppm) significantly lower zinc concentration than HP 1102 (85.63 ppm), In case of straw all the factors viz., variety, source and dose, individually interaction between source and dose, and control verus rest were found to be highly significant with respect to Zn content. It was also observed that the variety Kalyan sona utlised maximum zinc and HD 1553 minimum as indicated by their Zn content. So far as the quality was concerned, Kalyan sona was superior to all other varieties. Variety HP 1102 (66.97 ppm) was significantly better than HD 1553 (65.04 ppm). Similarly HD 1982 (67.53 ppm) was superior to HD 1553 (65 04 ppm) and sonalika (66.07 ppm). Nosignificant difference was observed between sona lika (69 07 ppm) and HD 1102 (66.97 ppm) and also between HD 1982 (67 53 ppm)

and HP 1102 (66.97 ppm). Among the sources zinc sulphate gave the best performance and zinc carbonate was poorest to increase in the zinc content of grain and straw. In case of straw the interaction between source and dose was found to be significant. With the application of higher dose of $ZnSO_4$, $ZnCl_2$ and ZnO increased the zinc content over their lower dose, respectively, while no significant difference was observed between higher and lower dose in case of $ZnCO_3$ and $Zn_3(PO_4)_2$ application. In the case of control versus rest of the treatments, significantly increased the zinc content (67.19 ppm) over control (45.0 ppm).

*Zn Removal By Wheat Crop* :

Mean individual effects and their interactions are presented in Table 5. The results presented in Table 5 indicated that uptake of zinc had declined progressively with successive cropping in different years The trend was in 1st year indicating the highest uptake followed by 2nd year and 3rd year. There was no significant difference recorded between the mean uptake in first two years but uptake in the first two years was significantly greater than that in 3rd year of cropping. Among the varieties (Table 5), Kalyan sona had recorded the highest uptake of zinc followed by HD 1982 but the variety Kalyan sona recorded significantly higher uptake than HP 1102, Sonalika and HD 1553. The varieties HD 1982, and HP 1102 were at par. Among the differentsources of zinc (Table 5) it is evident from the table $ZnSO_4$ had secored significantly higher uptake than all the other sources. The uptake of $ZnCl_2$ was significantly greater than those of $Zn_3(PO_4)_2$ and $ZnCO_3$. It was interesting ro note that when Zn was applied in the form of $ZnCO_3$, uptake was significantly lower than other sources. The higher dose of Zn had given significantly greater uptake than the lower dose which in terms recorded significantly higher uptake than control (Table 5). A gradual decrease in Zn concentration in th grain and straw and its uptake by all the varieties of wheat were observed. This may be due to decrease in an availability in soil and consequently low uptake by plants. Similarly successive increase in concentration of Zn was noticed with higher levels of zinc carriers Several workers including Sinha and Singh (1977) reported the increase in Zn concentration and uptake by maize. The data presented in present investigation are in line of the findings of Sakal *et al.* (1981) who observed increasing effect of zinc application on the concentration and uptake by wheat crop. Zinc sulphate increased Zn content and its uptake

maximum in all the varieties of wheat in comparison to other zinc fertilizers. This may be due to maximum solubility. On the other hand $Zn_3(PO_4)_2$ and $ZnCl_2$ did not improve the Zn concentration in grain and straw because these fwo are insolublo zinc fertilizers. Singh and Singh (1979) also observed that Zn concentration in grain and straw increased with the appli cation of increasing levels of zinc.

Finally it may be pointed out that among the wheat variety Kalyan sona gava the performance in Increasing the yield. The yield increased with increasing levels of Zn and Zinc sulphate gave the best performance and zinc carbonate the poorest. All the zinc fertilizers at higher levels of zinc application gave significantly greater uptake of Zn.

## REFERENCES


JACKSON, M L. 1967. *Soil Chemical Analysis.* Prentice Hall of India. Pvt. Ltd., New Delhi.

SAKAL, R., SINGH A.P., SINHA, H. and THAKUR. K.N. 1981. Evaluation of critical concentration of zinc in rice and wheat grown in Tarai soil. *J. Indian Soc. Soil Sci. 29* (1), 107-109.

SHUKLA, U.C. and RAJ, HANS, 1976 Zinc response in corn as influenced by genetic variability. *Agron. J , 68* (1) : 20-22.

SINGH, M. and SINGH K.S. 1979. Response of wheat to zinc fertilization at different levels of phosphorus in loamy sand soil; *J Indian Soc. Soil Sci , 27* (3) : 314-320

SINHA, N.P. and SINGH, J.P. 1977. Response of some maize germplasm to zinc in calcareous soils of North Bihar. *J. Indian Soc Soil Sci. 25* (4) : 422-425.


Table 1. Effect of sources of Zn on the yield of wheat (g/pot)

| Source of Zn | 1976-77 | | 1977-78 | | 1978-79 | |
|---|---|---|---|---|---|---|
| | Grain | Straw | Grain | Straw | Grain | Straw |
| $ZnSO_4$ | 6.26a | 12 77a | 6 02a | 12 14a | 5.70a | 11.27a |
| $ZnCl_2$ | 5 65b | 11.41ab | 5.61b | 11 28b | 5 26b | 10.48b |
| ZnO | 5.51b | 1· .00b | 5.45b | 10 99b | 5.23b | 10.36b |
| $ZnCe_3$ | 4 54d | 8.87d | 4.35d | 8 81d | 4 17d | 8.37d |
| $Zn_3(PO_4)_2$ | 4.96c | 9.98a | 4 86c | 9.76c | 4.63c | 9.35c |
| C D. (5%) | 0.28 | 0.61 | 0.29 | 0.54 | 0.22 | 0.43 |

Figures with different letters differ significantly at $P<0.05$

Table 2. Effect of variety on the yield of wheat (g/pot)

| Variety | 1976-77 | | 1977-78 | | 1978-79 | |
|---|---|---|---|---|---|---|
| | Grain | Straw | Grain | Straw | Grain | Straw |
| HD 1553 | 5 05bc | 10 11b | 4.60c | 9.79b | 4 66c | 0.25c |
| HD 1982 | 5 58 | 10.86a | 5 30ab | 10.79a | 4 90b | 9 86b |
| Sonalika | 4 94 | 10 01b | 4.96c | 9.98b | 4 71bc | 9.51bc |
| HP 1102 | 5.25 | 10 57ab | 5.08bc | 10.28ab | 4.81bc | 9.68b |
| Kalyan sona | 3.42 | 10.82a | 5 38a | 10 73a | 5.24a | 10 41a |
| C D. at 5% | 0.27 | 0.58 | 0.28 | 0.61 | 0.21 | 0.41 |

Figures with different letters differ significant at $P<0.05$

Table 3 Effect of different levels of Zn on yield of wheat (g/pot)

| Dose | 1976-77 | | 1977-78 | | 1978-79 | |
|---|---|---|---|---|---|---|
| | Grain | Straw | Grain | Straw | Grain | Straw |
| $D_0$(control) | 3.36c | 7.13c | 3.59c | 7.11c | 3.61c | 7.27c |
| $D_1$(2.5 ppm) | 5.06b | 10.30b | 4.98b | 10.15b | 4.72b | 9.47b |
| $D_2$(5 ppm) | 5.71a | 11.34a | 5.64a | 11.08a | 5.27a | 10.61a |
| $D_3$(S.E. de mean) | 0.14 | 0.31 | 0.15 | 0.27 | 0.11 | 0.22 |
| C.D.(5%) for $D_1$ and $D_2$ | 0.17 | 0.38 | 0.18 | 0.34 | 0.14 | 0.27 |
| C.D. at 5% for $D_0$ $D_1$ and $D_0$ and $D_2$ | 0.44 | 0.95 | 0.46 | 0.83 | 0.35 | 0.67 |

Figures with different letters differ significant at $P<0.05$.

Table 4. Zinc concentration (ppm) of wheat grain and straw (Pooled data of three years)

| Treatment | $V_1$ | | $V_2$ | | $V_3$ | | $V_4$ | | $V_5$ | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Grain | Straw | Grain | Straw | Grain | Straw | Grain | Straw | Grain | Straw |
| $T_1$ | 72 | 46 | 74 | 47 | 72 | 44 | 72 | 42 | 73 | 43 |
| $T_2$ | 67 | 66 | 90 | 68 | 88 | 67 | 89 | 68 | 91 | 70 |
| $T_3$ | 94 | 72 | 94 | 73 | 94 | 72 | 95 | 72 | 96 | 76 |
| Mean | 90 | 69 | 92 | 71 | 91 | 69 | 92 | 70 | 94 | 73 |
| $T_4$ | 83 | 63 | 88 | 66 | 85 | 64 | 87 | 75 | 90 | 70 |
| $T_5$ | 86 | 71 | 92 | 73 | 88 | 72 | 89 | 72 | 93 | 74 |
| Mean | 85 | 67 | 90 | 69 | 87 | 68 | 88 | 69 | 91 | 72 |
| $T_6$ | 82 | 62 | 86 | 65 | 84 | 64 | 84 | 64 | 88 | 68 |
| $T_7$ | 84 | 69 | 90 | 71 | 86 | 70 | 87 | 71 | 91 | 72 |
| Mean | 83 | 66 | 88 | 68 | 85 | 67 | 86 | 67 | 89 | 70 |
| $T_8$ | 78 | 60 | 83 | 62 | 76 | 61 | 78 | 63 | 83 | 65 |
| $T_9$ | 80 | 62 | 86 | 64 | 80 | 62 | 81 | 63 | 87 | 67 |
| Mean | 79 | 61 | 84 | 63 | 78 | 62 | 80 | 63 | 85 | 66 |
| $T_{10}$ | 79 | 62 | 84 | 64 | 79 | 63 | 80 | 63 | 84 | 65 |
| $T_{11}$ | 82 | 63 | 87 | 65 | 81 | 63 | 82 | 65 | 88 | 67 |
| Mean | 81 | 63 | 85 | 64 | 80 | 63 | 81 | 64 | 86 | 66 |
| Mean of source | 84 | 65 | 88 | 67 | 84 | 66 | 85 | 68 | 89 | 69 |

Table 5. Mean uptake of zinc by different varieties of wheat during different years under continuous cropping and different sources and doses of zinc

| Continuous cropping years | Mean uptake (mg/plot) | Varieties | Mean uptake mg/plot | Source of zinc | Mean uptke mg/pot | Dose of zinc | mean uptake mg/pot |
|---|---|---|---|---|---|---|---|
| 1976 (first year) | 1.17a | HD 1553 | 1.03c | $ZnSO_4$ | 1.49a | $D_0$ (Control) | 0.58c |
| 1977 (2nd year) | 1.12a | HD 1982 | 1.18ab | $ZnCl_2$ | 1.25b | $D_1$ (2.5 ppm) | 1.07b |
| 1978 (third year) | 1.02 | Sonalika | 1.04c | ZnO | 1.15bc | $D_2$ (5ppm) | 1.24a |
| | | HP 1102 | 1.09bc | $ZnCO_3$ | 0.91d | | |
| | | Kalyan Sona | 1.20a | $Zn_3(PO_4)_2$ | 1.02c | | |
| C.D. (5%) | 0.07 | C.D. (5%) | 0.09 | C.D. (5%) | 0.09 | C.D.(5%) for $D_1$ & $D_2$ | 0.08 |
| | | | | | | For $D_1$ & $D_2$ with $D_0$ | 0.14 |

Figures with different letters differ significantly at $P > 0.05$