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RESPONSE OF INOCULATED SOYBEAN TO IRON AND ZINC APPLICATION

Khan Zada, Saeed Ahmad & Saeed A. Cheema
University of Agriculture, Faisalabad

To study the effect of Fe and Zn on soybean dry matter yield and nutrient accumulation, experiments were conducted in pots at Nuclear Institute for Food and Agriculture (NIFA) during 1983 and NWFP Agricultural University, Peshawar during 1984 on clay loam and silty clay loam soil. The treatments included 0,7,14 kg Iron (Fe) ha^{-1} and 0,5,10 kg zinc (Zn) ha^{-1} alone and in combination. Dry matter yield increased in response to single application of Fe and Zn and their combined application resulted in still higher dry matter. Nitrogen fixation efficiency increased with single application of Fe and Zn and their combined application resulted in much higher nitrogen efficiency. There was positive correlation between dry matter yield and total nitrogen recovery.

INTRODUCTION

The visual responses to small and corrective applications of Fe and Zn to soybean may be unbelievably striking but more often the response, if any, would result in some increase in yield with no apparent change in plant growth and dry matter production. The nutrient accumulation and translocation in soybean varies with the type of nutrient, growth stage and growing season. Few studies concerning dry matter, N accumulation and nutrient distribution in soybean have included the information on the micronutrients, soil water conditions or genetic variations. Dry matter production is directly related with the vegetative growth, nitrogen fixation and nitrogen metabolism (Possingham, 1957). Shukla and Yadar (1982) also reported increased dry matter with Zn application due to effective nitrogen fixation. The beneficial effects of Zn and Fe in nitrogen accumulation are well documented (De Meterio et al., 1972; Haque et al., 1980, and Keeper and Singh, 1969). Micronutrient concentration in soybean plants varies with soil pH, p contents, soil temperature and soil moisture (De Mooy et al., 1973), where diffusion might be an important mechanism for movement and accumulation of nutrients (Oliver and Barber, 1966). The interaction of Fe and Zn is also important. Reddy et al, (1978) reported that Fe concentration of 5 ppm or more strongly reduced Zn uptake. Lingle et al. (1963) observed that excess of Zn reduced the translocation of Fe in soybean tops as well as the root absorption. It was, therefore, planned to investigate the effect of Fe and Zn on dry matter yield and nutrient accumulation of inoculated soybean.

MATERIALS AND METHODS

Two experiments were conducted to study the response of Fe and Zn in pots each having 25kg of finely ground soil, at Nuclear Institute for Food and Agriculture (NIFA) Peshawer and NWFP Agricultural University, Peshawar during 1983 and 1984, respectively. The soils were analyzed for physico – chemical properties and nutrient status (Table.1). Iron (Fe) at the rate of 0,7,14 and Zinc (Zn) at the rate of 0,5,10 kg ha^{-1} alone and in combination were applied before sowing on soil weight basis. Inoculated seeds of soybean cv. Bragg were sown on August 2, 1983 and May 20, 1984 at NIFA and NWFP Agricultural University, Peshawar, respectively. Thinning was done after germination and five plants per pot were allowed to grow for agronomic and biologic studies. A basal dose of NPK @ 50, 100 and100 kg ha^{-1} was applied before sowing and thoroughly incorporated into the soil. The treatments were replicated three times in completely randomized design. The

Table 1. **Physico-chemical analysis of soil**

Characteristic	NIFA-Peshawar	Agri.Univ.Peshawar.
Clay	46.6%	31.2%
Silt	34.0%	53.0%
Sand	19.4%	15.8%
Textural class	clay loam	silty clay loam
Organic matter	0.86%	1.08%
pH	8.0	7.6
Electrical conductivity	3.5 dSm^{-1}	1.8 dSm^{-1}
Nitrogen i. Before sowing	0.043%	0.089%
ii. After harvest	0.072%	0.095%
Available P_2O_5 (Olson)	30 ppm	51ppm
Available K_2O (NH_4oAc)	337 ppm	570 ppm
Available Fe (EDTA extractable)	12.13 ppm	6.63 ppm

data were subjected to statistical analysis and Duncan's Multiple Range Test was used to test the differences between treatment means (Steel and Torrie, 1980).

RESULTS AND DISCUSSIONS

Perusal of the data in Table-2 reveal that dry matter yield was significantly affected by micronutrient application during both the years. There was considerable increase in dry matter yield with single or combined application of Fe or Zn compared with the control. Combination of both of the elements showed better response, particularly at higher rates. It is possible that combined application of Fe and Zn enhanced metabolic activity resulting in better vegetative growth through involvement in nitrogen fixation and nitrogen metabolism as documer ... ıy Possingham(1957). This might ... e to increased nodulation of the ... al biomass N(Table 3) which ... increased dry matter. Shukla and Yadar (1982) also reported increased dry matter due to nodulation and efficient N fixation with Zn application. The combined treatments also had significant improvement in dry matter yield.

Nitrogen fixation and nitrogen fixing efficiency of soybean in the form of total N recovery (plant uptake) improved linearly with Fe and Zn applied alone and in combination (Table 3). The application of Zn was more effective in the fixation of nitrogen as indicated by more total biomass N than that by Fe. This might be due to metabolic role of Zn in effective root growth for increased nodulation and dry matter yield (Table 2). Relatively less effect of applied Fe to induce N fixation may partially be due to its higher level in soil, just approaching the sufficient level for plant growth (Mortvedt et al. , 1972). The beneficial effects of Zn nutrition in nitrogen fixation have been documented by De Meterio et al., (1972), Haque et al.,

Table 2. Effect of Fe and Zn on dry matter yield

Micronutrient			Yield (g p⁻¹)			Increase over control(%)		
Treat-ment	Fe kg	Zn ha^{-1}	1983	1984 (g pot^{-1})	Mean	1983	1984	Mean
Control	0	0	35.5c	36.9g	36.2e	–	–	–
Fe_1	7	0	39.2bc	40.5f	39.8de	10.4	9.7	10.0
Fe_2	14	0	40.3b	41.2ef	40.7cde	13.5	11.6	12.5
Zn_1	0	5	40.0b	43.9cd	42.5cd	15.5	18.9	17.2
Zn_2	0	10	41.2b	42.1de	41.6cde	16.1	14.1	15.1
$Fe_1 + Zn_1$	7	5	40.0b	43.5c	41.8cde	12.6	17.9	15.2
$Fe_1 + Zn_2$	7	10	47.3a	46.5b	46.9abc	33.2	26.0	29.6
$Fe_2 + Zn_1$	14	5	48.9a	47.6b	47.9ab	37.7	27.5	32.6
$Fe_2 + Zn_2$	14	10	49.5a	48.9a	49.2a	39.4	32.5	35.9

Mean values in a column not sharing a letter in common differ significantly (P = 0.05)

Table 3. Effect of Fe and Zn on total biomass N indicating nitrogen fixation and nitrogen fixation efficiency.

Micronutrient			Biomass N (g pot^{-1})			Increase over control %		
Treat-ment	Fe kg	Zn ha^{-1}	1983	1984	Mean	1983	1984	Mean
Control	0	0	1.25f	1.30i	1.28g	–	–	–
Fe_1	7	0	1.48e	1.51h	1.50f	18.4	16.2	17.2
Fe_2	14	0	1.56d	1.58g	1.57e	24.8	21.5	22.6
Zn_1	0	5	1.56d	1.60f	1.58e	24.8	23.1	23.4
Zn_2	0	10	1.61c	1.61e	1.61d	28.8	23.8	25.8
$Fe_1 + Zn_1$	7	5	1.63c	1.69d	1.66c	30.4	30.0	29.7
$Fe_1 + Zn_2$	7	10	1.85b	1.82c	1.83c	47.2	40.0	42.9
$Fe_2 + Zn_1$	14	5	1.91b	1.87a	1.89a	52.8	43.8	47.6
$Fe_2 + Zn_2$	14	10	1.88a	1.86b	1.87a	50.4	43.1	46.1

Mean vallues in a column not sharing a letter in common differ significantly at (P = 0.05).

(1980), Kapur et al., (1975) and Possingham (1957). Combined application of Zn and Fe resulted in more uptake of N which might be due to micronutirent interaction. Though Fe application increased total N recovery but not to the level as Zn did which might be ascribed to Fe-chlorosis probably due to added phosphorus thus hampering nitrogen fixation. Similar findings have also been reported by Morachan et al., (1971)

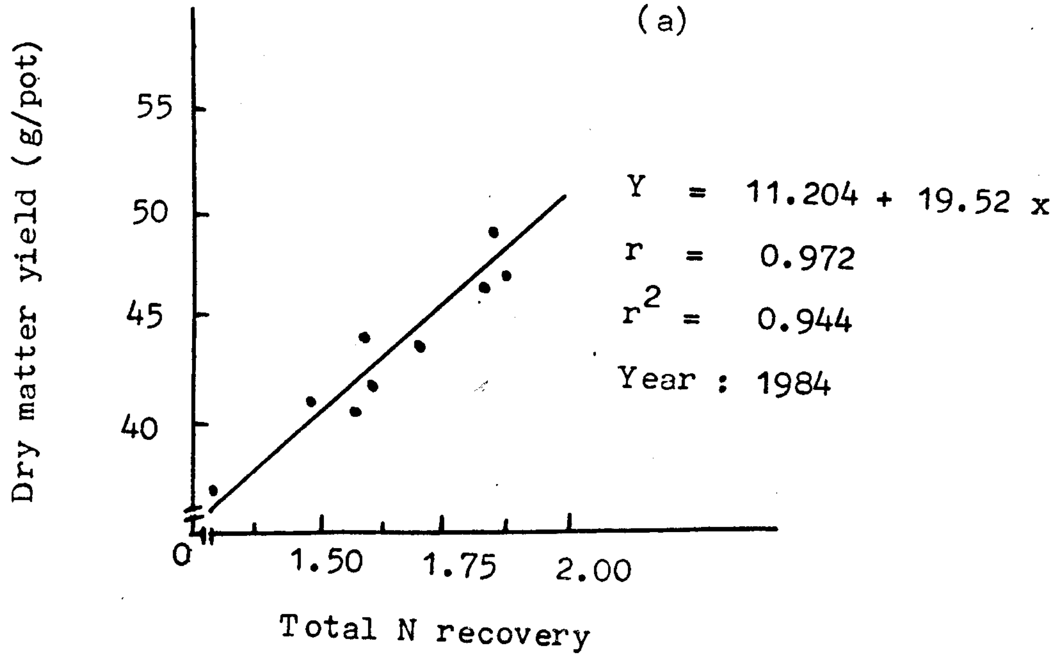
Fe and Zn concentration in the plants increased with increase in the respective nutrient application (Table 4). Fe and Zn accumulation was higher in their single application particularly at higher rate , but Fe – Zn combination did not show a clear trend. Fe and Zn at the rates of 14 and 5 kg ha^{-1} accumulated more of Fe while Fe and Zn at the rates of 14 and 10 kg ha^{-1} accumulated more of Zn. Such differences may be due to interaction with soil pH, phosphorus contents, soil temperature and soil moisture conditions as reported by De Mooy et al., 1973.

The Fig.1 reveals the positive and highly significant correlation between dry matter yield and total N recovery. The corresponding determination coefficients (r^2) of both the years showed the reliability of interdependence between the two parameters. The linear line of regression indicated that with an increase in the nitrogen accumulation as a result of the micronutrients nutrition, there was a corresponding increase in dry matter.

Table 4: Effect of Fe and Zn on nutrients concentration of inoculated soybeen.

Micronutrient			Fe conc. (ppm)			Zn conc. (ppm)		
Treat-ment	Fe kg	Zn ha^{-1}	1983	1984	Mean	1983	1984	Mean
Control	0	0	120e	124f	122f	26.3g	26.2ef	26.3c
Fe_1	7	0	150c	142d	146c	25.4g	28.5d	26.9c
Fe_2	14	0	170a	151b	160a	25.2g	27.9de	26.6c
Zn_1	0	5	140d	146c	143d	33.8c	31.7c	32.7b
Zn_2	0	10	140d	141d	140e	39.2a	35.9b	37.6a
Fe_1+Zn_1	7	5	160b	146c	153b	32.9d	34.2b	33.6b
Fe_2+Zn_2	7	10	150c	156c	153b	32.8e	34.9b	33.8b
Fe_1+Zn_1	14	5	160b	159a	159a	29.0f	26.0f	27.5c
Fe_2+Zn_2	14	10	150c	128e	139e	38.4b	40.1a	39.3a

Mean values in a column not sharing a letter in common differ significantly at (P = 0.05).



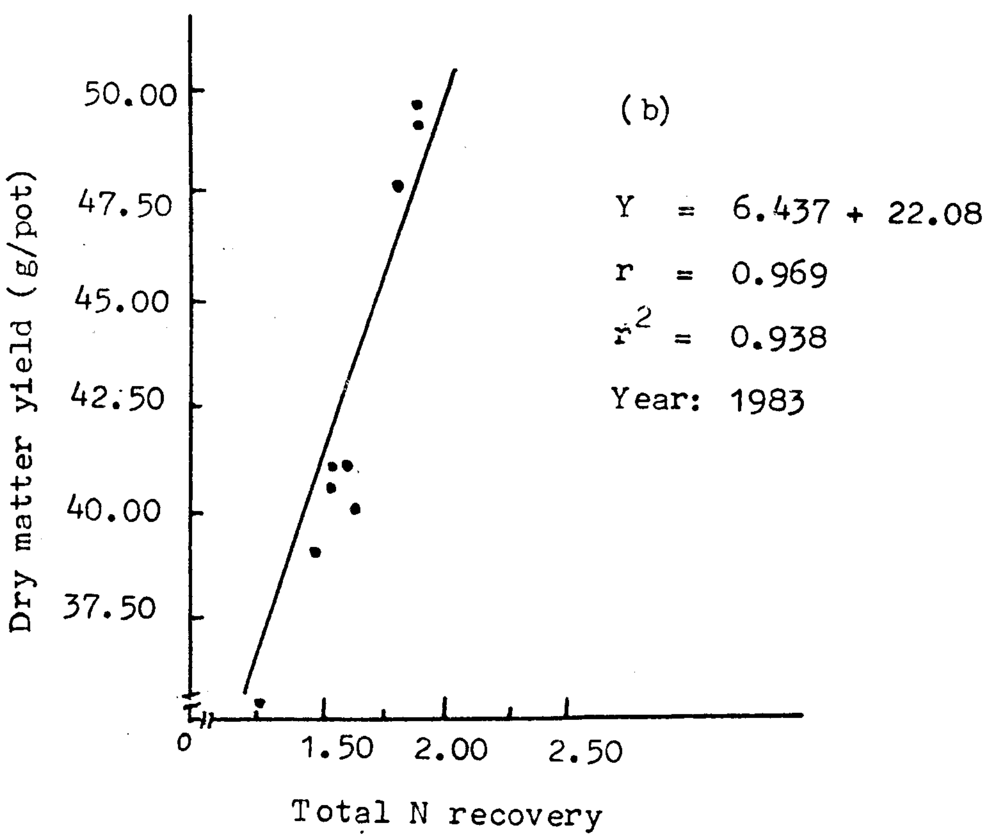


Fig.1.Line of regression and relationship between dry matter and total N recovery of inoculated soybean during 1983(a) and 1984(b).

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