Field Crops Research, 3 (1980) 211—214.

IRON CHLOROSIS IN CHICKPEA (*CICER ARIETINUM* L.) GROWN ON HIGH pH CALCAREOUS VERTISOL

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(Accepted 24 April 1980)

ABSTRACT

Saxena, N.P. and Sheldrake, A.R., 1980. Iron chlorosis in chickpea (*Cicer arietinum* L.) grown on high pH calcareous vertisol. *Field Crops Res.*, 3: 211—214.

Genotypic differences exist in the sensitivity of cultivars of chickpea to iron deficiency. Sensitive cultivars exhibited typical iron deficiency symptoms when grown on calcareous soils with high pH. $FeSO_4$ sprays (0.5%) corrected deficiency symptoms and increased yields by up to 50% in cultivars inefficient in iron utilization, but gave no increase in cultivars that were efficient.

INTRODUCTION

In chickpeas, cultivar differences in sensitivity to iron deficiency have been reported from sand culture studies (Agarwala et al., 1971), and iron chlorosis on high pH calcareous soils has been reported in Syria and Lebanon (Saxena, 1979). In some instances, varietal differences within species have been found to be as great as differences between species (Brown, 1979). We have observed differential reactions in chickpeas grown at ICRISAT Center on calcareous vertisols with a pH of 8.0 to 9.0. There have been no published reports of attempts to quantify losses in yield associated with iron deficiency symptoms in this crop or to quantify responses to iron application when deficiency symptoms are not present. Both soil and foliar applications of inorganic sources of iron have been shown to correct iron chlorosis and increase yields in sorghum and rice (Mathers, 1970; Mortvet and Giovdana, 1971; Westfall et al., 1971), but soil application requires large amounts of inorganic iron. We have therefore examined foliar sprays, which require much smaller amounts of the chemical, and observed the responses of chickpea cultivars with a range of different efficiencies in iron utilization.

MATERIALS AND METHODS

Three chickpea cultivars, ICC-10218 (Fe efficient), ICC-1685 (moderately Fe efficient), and ICC-10157 (Fe inefficient), identified in a germplasm maintenance planting, were planted in a split plot design with cultivars as main plots, and treatments of foliar iron spray as subplots in three replications. The plot size was four rows, each 2 m long; the two central rows were harvested for estimation of dry matter and grain yield.

The trial was planted on 16 October 1976, on vertisol having a pH of 8.2 in the postrainy (rabi) season of 1976—1977 at ICRISAT Center, Patancheru, Hyderabad. Seeds were dry-planted, 10 cm apart, in rows spaced 30 cm apart. A light postsowing sprinkler irrigation was given to ensure that germination and establishment were uniform.

A 0.5% w/v solution of ferrous sulphate at the rate of 0.4 l/plot (24 m^2) was used with 1 ml/l of teepol as a wetting agent 26 days after sowing. The spray treatments were (1) control (nonsprayed), (2) two sprays (72 and 87 days after sowing), (3) five sprays (26, 41, 56, 71, 86 days after sowing).

The cultivars ICC-10218 and ICC-1685 flowered 65 days after sowing, whereas the inefficient ICC-10157 flowered 79 days after sowing. All cultivars were harvested 144 days after sowing.

RESULTS

Symptoms

Chlorosis of the younger leaves is a general iron deficiency symptom in most plant species (Wallace and Lunt, 1960), and this was observed in cultivars ICC-10157 and ICC-1685. However, iron efficient cultivar ICC-10218 did not exhibit any deficiency symptom. Additionally, in cases of severe deficiency the pinnae (leaflets on a compound leaf) became whitish, thin, and withered or fell. The size of the pinnae was also reduced. The deficiency appeared in early stages of growth when plants had three to four leaves. Without iron sprays, the deficiency symptoms completely disappeared 60—70 days after sowing, while in sprayed treatments, symptoms disappeared 5—6 days after spraying. Plants sprayed with $FeSO_4$ matured and senesced 10—15 days earlier than the non-sprayed plants.

That chlorosis symptoms on iron inefficient cultivars were due to deficiency of iron alone was confirmed by spraying solution of analytical grade of different salts of iron including $FeSO_4$, $FeCl_2$, Fe-EDTA, and Fe-tartrate. In all cases the deficiency symptoms disappeared after the foliar application of the iron salt.

Yield of the inefficient ICC-10157 and moderately efficient ICC-1685 increased with two iron sprays by 48 and 39%, respectively, whereas no increase in yield of the efficient cultivar was observed with iron spray. Within each cultivar, yields were similar in both spray treatments (Table I).

TABLE I

Effect of 0.5% ferrous sulphate spray on the yield of chickpea cultivars with a range of efficiencies in iron utilization

Cultivar	Yield (kg/ha)			Cultivar means
	Control (unsprayed)	Two sprays	Five sprays	
ICC-10157 (inefficient	950	1407	1280	1212
ICC-1685 (moderately efficient)	557	777	830	721
ICC-10218 (efficient)	1173	1177	1177	1176
Treatment means	893	1120	1095	
	LSD (0.05)			LSD (0.05)
Treatments:	173	Treatments in a cultivar:		299
Cultivars:	154	Cultivars in a treatment:		273

In another experiment foliar spray of $FeSO_4$ on three iron efficient cultivars did not result in any significant increase in yield.

DISCUSSION

In the two chickpea cultivars where iron deficiencies occurred, these deficiencies disappeared at later stages of growth even if not sprayed with $FeSO_4$, but the yields were considerably reduced in non-sprayed plants. Recovery after spraying was very uniform in chickpeas as compared to other crops (Saxena et al., 1971). It is likely that the presence of acid exudate (Sahasrabuddhe, 1914), on the foliage keeps the iron in an available and mobile form. Dependence of mobility and availability of iron in plant tissues and around roots has been reported (Tanaka and Navasero, 1966; Saxena et al., 1971). Non-sprayed plants also matured and senesced later, but the increase in growth duration did not compensate for the losses in yield due to iron deficiency. The lack of response to foliar application of $FeSO_4$ in efficient cultivars indicates that there is no latent deficiency of iron.

Iron inefficiency, even if it results in only transitory deficiency symptoms, is an undesirable character. It is encouraging that inefficient chickpea plants can be easily recognized, so effective selection for iron efficiency can be practised. Results of this study suggest a situation parallel to that in soybeans (Weiss, 1942).

ACKNOWLEDGEMENTS

We thank Mr L. Krishnamurthy for technical assistance.

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