ZINC AND IRON APPLICATION TO OPTIMIZE SEED YIELD OF MUSTARD

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ABSTRACT:- A study was conducted on a sandy clay loam soil at the National Agricultural Research Centre, Islamabad, Pakistan, during 2005 and 2006. The mustard (*Brassica juncea*) variety BARD-1 was treated with various levels of Zn and Fe, (0-0, 0-1.5, 0-3, 2.5-0, 2.5-1.5, 2.5-3, 5-0, 5-1.5 kgha^{-1} and 5-3 kgha^{-1}), respectively. A basal dose of 90N and 60P kg ha^{-1} was applied, in the form of Urea and triple super phosphate (TSP) with Zn and Fe. The increase in Zn and Fe fertility from 0-1.5 to 5-1.5 kg ha^{-1} increased yield of BARD-1. The maximum yield response was recorded when 5 kg ha^{-1} Zn and 1.5 kg ha^{-1}Fe were applied. Beyond this level, no further increase in yield was recorded in any mustard traits. A positive correlation was recorded between seed yield and 1000-seed weight with the application of 5 kg Zn ha^{-1} and 1.5 kg Fe ha^{-1} in combination at the time of sowing. It can therefore be concluded that 100 % seed yield of mustard variety BARD-1 increased at 5 Zn: 1.5 Fe kg ha^{-1} as a result of increased pods plant^{-1}, number of seeds pod^{-1} and 1000-seed weight.

Key Words: Brassica juncea; Zinc, Iron; Combination; Yield; Yield Components, Pakistan.

INTRODUCTION

Mustard *(Brassica juncea* L.) is quite responsive to micronutrients. Among the micronutrients zinc deficiency is wide spread on a wide range of soils (Graham et al., 1992). Most of the soils in Pakistan are deficient in zinc, thus soils with low available zinc in the topsoil and subsoil constitute one of the key limiting factors for the sustainable crop production (Grewal et al.,1997) and application of Zn with other fertilizers needs to be practiced to overcome this deficiency. The significant effect of micronutrients application on the growth of mustard crop, regarding plant height, number of pods per plant, number of seeds per pod and dry matter production per plant can be interpreted in terms of enhanced metabolic functions of micronutrients in the plant (Amberger, 1980). Under Egyptian conditions positive effects of micronutrients on crops were reported in several studies by Abdalla and Mobarak (1992) who found increase in plant height, dry weight and uptake due to continuous addition of Fe, Mn and Zn through irrigation water. Application of adequate fertilizers led to increase the crop yields, improved the nutrient element concentration in plant tissue and soil macro and micro nutrients status (Adediran et al., 2004). Deficiencies of any one of the micronutrients adversely affect

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plant growth, development and ultimately yield, thus minimize the usefulness of other agricultural inputs including NPK fertilizers. The efficiency of these inputs can substantially be increased by the application of micronutrients particularly zinc and iron (Khalil et al., 1996, Dhanase-karan and Bhuvaneswari, 2004). Extensive field experimentation on micronutrients indicate that on average 49 % of cropped area in Punjab, 37% in Khyber Pakhtu-nkhawa, 47% in Sindh, 92% in Balochistan and 28% in Azad Jammu and Kashmir are deficient in zinc (Rashid, 1994; NFDC,1998) while on an average 15% of field crops in Pothwar, 14% in Kyber Pakhtun-Khawa and 1% in Sindh and Balochistan were diagnosed as iron deficient (Khattak and Parveen 1988; Memon et al., 1989; Ismail et al., 1994). Iron deficiency is of much lesser magnitude compared to zinc and an activity of these nutrients decreases 100-fold for each unit increase in pH value (Lindsay and Norvell, 1978). Positive response of various field crops including rapeseed and mustard to zinc and iron application in separate investigations have been reported by a number of researchers (Attia et al., 2004; Mankar et al., 2003; Rashid et al., 1997) but no interactive effect of Zn and Fe has been done under the irrigated conditions of Pothowar. Keeping in view the key role played by zinc and iron nutrition in plant seed yield and its yield components, this study was conducted to find out the suitable dose of interactive effect of Zn and Fe application on mustard variety BARD-1.

MATERIALS AND METHOD

The experiment was conducted on BARD-1 (*Brassica juncea L.*) mustard variety under irrigated conditions at the National Agricultural Research Centre, Islamabad during 2005 and 2006. Experiments were laid out in a randomized complete block design with 4 replications during both the years. Net plot size was 6 m^2 containing 45 m long with 30 cm row spacing. Crop was planted in the first week of October during both the years of study. Seed was sown @ 5 kg ha^{-1} with the help of hand seed drill. Soil analysis was conducted according to procedures of Winkleman et al. (1990). The soil analysis showed that the texture of experimental site was sandy clay loam with 1.4 dsm^{-1} E.C.; 7.8 pH 0.82% organic matter; 3.5 mg kg^{-1} available phosphorus; 0.05 % total nitrogen; 0.43 mg kg^{-1} extractable Zn; 1.76 mg kg^{-1} Fe, 0.26 mg kg^{-1} Mn and 0.78 mg kg^{-1} Cu. Treatment combinations consist of three levels of zinc i.e., 0, 2.5 and 5 kg ha^{-1} and three levels of Fe i.e., 0, 1.5 and 3 kg ha^{-1}, thus making total nine treatments including one check (with out Zn & Fe).

N and P were applied @ 90-60 kg ha^{-1} in the form of Urea and TSP, respectively. The N was equally split into three parts and applied with second, third and fourth irrigations while all phosphorus, Zn (as zinc chloride) and Fe (as ferric chloride) were incorporated in the soil at the time of sowing. The oil content in the seed was estimated at maturity by Nuclear Magnetic Resonance (NMR) spectrop-hotometer. The oil content was expressed in percentage (Anonymous, 1975). Data on days to flowering, days to maturity, plant height, pods plant^{-1}, seeds pod^{-1}, 1000-seed weight, seed yield and oil content were recorded at maturity. Seed yield per plot was estimated by harvesting and threshing the two middle rows from each plot and then calculating it in kg ha^{-1}. The data collected were analyzed statistically by using Least Significant Difference (L.S.D) test at 5% level of probability (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

The yield determining components (number of pods plant^{-1}, number of seeds pod^{-1}, 1000-seed weight and seed yield) were significantly influenced by different combinations of zinc and iron during both the years (Table 1). The differences in the seed yield were largely because of variations in the yield components viz., number of pods plant^{-1}, number of seeds pod^{-1} and 1000-seed weight. Among the different combinations of zinc and iron application recorded in different treatment combinations, 5-1.5 kgha^{-1} produced the highest plant height of 244 cm and 233 cm during 2005 and 2006, respectively. This dose was significantly superior over 0-1.5, 0-3 kg ha^{-1} treatment and control. The crop plots receiving Zn and Fe @ 5 and 1.5 kg ha^{-1}, respectively, might have been helped in terms of vigorous roots growth, cell elongation, cell division, formation of chlorophyll resulting in higher photosynthesis, thus converting greater photosynthesis toward final plant height. Ai-Qing et al. (2011) found that application of zinc and iron in combination increased leaf chlorophyll and dry weight in wheat. Zn and Fe combinations @ 5-1.5 kg ha^{-1} had significant influence on yield resulting in 100 % increase in seed yield (1272 kg ha^{-1} and 1526 kg ha^{-1}) during 2005 and 2006, respectively. It was significantly superior over 0-1.5 (637 and 1165 kg ha^{-1}), 0-3 (740 and 1088 kg ha^{-1}), 2.5-0 (880 and 1164 kg ha^{-1}) and control (573 and 1087 kg ha^{-1}) treatment combinations of Zn and Fe during 2005 and 2006, respectively. This indicated superior effect of Zn and Fe combinations than individual effects. Gaffar et al. (2011) observed that application of zinc and iron in combination increased sugarcane yield and quality. This might be due to synergetic effect of both nutrients on yield components that are directly responsible for higher brassica seed yield. Overall results indicated that zinc and iron fertilizers application in combinations either at high or low rates proved better than Zn and Fe

Table 1. Mustard yield and yield components as affected by different zinc and iron levels during 2005 and 2006

Treatments Zn and Fe (kg ha^{-1})	Days to flowering	Days to Maturity	Plant height (cm)	Pods per plant	Seeds per pod	1000-seed weight (g)	Seed yield (kg ha^{-1})	Oil content (%)
2005								
0.0-0.0	53	185	212	299	9	1.92	573	40
0.0-1.5	52	184	214	305	12	2.01	637	40
0.0-3.0	54	183	224	328	11	2.16	740	41
2.5-0.0	51	183	230	317	12	2.15	880	40
2.5-1.5	51	182	236	331	11	2.35	897	40
2.5-3.0	50	183	225	286	11	2.32	1013	41
5.0-0.0	50	179	227	344	12	2.31	1081	41
5.0-1.5	51	178	244	362	13	2.37	1272	42
5.0-3.0	52	182	227	356	12	2.36	1148	41
L.S.D (0.05)	1.56	2.16	18.31	56	1.60	0.10	171	
2006								
0.0-0.0	54	182	224	324	14	2.12	1165	40
0.0-1.5	55	184	224	330	13	2.13	1088	41
0.0-3.0	53	182	231	290	11	2.17	1164	40
2.5-0.0	52	182	222	336	12	2.61	1277	41
2.5-1.5	53	183	230	366	13	2.64	1316	41
2.5-3.0	52	182	225	328	11	2.62	1398	40
5.0-0.0	52	181	233	385	15	2.69	1526	41
5.0-1.5	53	182	226	359	13	2.65	1477	40
5.0-3.0								
L.S.D (0.05)	1.56	2.14	17.95	73	1.56	0.11	205	

fertilizer applications alone confirming the findings of Meena et al. (2006) and Saxena et al. (2005).

The 1000-seed weight showed significant differences between control and the treatments which, received zinc @ 2.5 and 5 kg ha^{-1} combination with 3 and 1.5 kg ha^{-1} iron, respectively during both the years. The brassica plots receiving 5--1.5 kg ha^{-1} zinc and iron illustrated maximum 1000-seed weight of 2.37and 2.69 g, respectively during 2005 and 2006. These results were significantly higher than treatment combination of 0-1.5 (2.01 and 2.12 g), 0--3 (2.16 and 2.13 g), 2.5-0(2.15 and 2.17 g) of Zn and Fe and control (1.92 and 2.21 g) during 2005 and 2006, respectively. Heidarian et al. (2011) reported that foliar application of zinc and iron in combination increased 1000-grain weight and number of pods $plant^{-1}$.

Data on number of seeds pod^{-1} reve-aled that treatments receiving 5-1.5 $kgha^{-1}$ zinc and iron demonstrated the highest number of seeds pod^{-1} i.e.,13 and 15 during 2005 and 2006, respectively. Data regarding the number of pods $plant^{-1}$ showed that treatment that received 5-1.5 $kgha^{-1}$ zinc and iron, respectively produced higher number of pods $plant^{-1}$ (362 and 385) over treatments 0-.5 (305 and 324), 0-3 (328 and 330), 2.5-0(317 and 290) zinc and iron, respectively and control (299 and 311) during 2005 and 2006. Data regarding days to flowering and maturity indicated that application of micronutrients enhanced maturity (178 and 181 days) as compared to control (185 and 186 days) during 2005 and 2006, respectively. Blaylock (1995), reported that maintaining of adequate zinc nutrition in bean promotes earlier maturity. Application of zinc and iron either alone or in any combination did not affect oil content significantly during both the years of experimentation.

Hence it is concluded that application of 5 $kgha^{-1}$ zinc and 1.5 kg ha^{-1} iron in addition to 90-60 kg ha^{-1} NP fertilizer was optimal treatment for 100 % increase in seed yield in mustard variety BARD-1 under climatic conditions of National Agricultural Research Centre, Islamabad. Further increase in zinc and iron levels have no significant effect on yield and yield components of mustard variety BARD-1. Further experimentation is needed in different agro-ecological zones of the country to optimize zinc and iron deficiency in the soils.

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