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MACRO AND MICRO-NUTRIENTS VARIATION AMONGST SIX GENOTYPES OF *BRASSICA JUNCEA* (MUSTARD) INFECTED WITH *ALBUGO CANDIDA* (WHITE RUST)

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ABSTRACT

The changes in macro and micro-nutrients were investigated in cotyledonary and true leaves of six genotypes of *Brassica juncea*: Kranti, Varuna, EC-399296, EC-399299, EC-399313 and EC-399301 inoculated with *Albugo candida*. The nitrogen content was decreased and was highest in genotype Varuna (0.66% dry wt.) followed by Kranti (0.64% dry wt.) after inoculation at cotyledonary stage while lowest was observed in EC-399299 (0.49% dry wt.). At true leaf stage, genotype Kranti had highest nitrogen content (0.78 and 0.82% at 14 and 21 DAI, respectively) while lowest was recorded in EC-399301 (0.56 and 0.66 at 14 and 21 DAI, respectively). Similarly, higher content of Zinc and manganese were recorded in true leaves of EC 399301 at 21 DAI (44.86 and 60.92 μg/g dry wt., respectively). The susceptible response of genotype EC-399301 at cotyledonay stage and resistant reaction at true leaf stage might be because of having higher content of nitrogen, lower content of zinc and manganese at cotyledonay stage and vice-versa. However, phosphorus and potassium content appear to play no significant role in making the differences in reaction to white rust at cotyledonary and true leaf stages of EC-399301.

INTRODUCTION

Brassica juncea (mustard) (AABB = 36) is an important oilseed species, particularly in South Asia. *Brassica* species commonly called as rapeseed-mustard are the third most important oilseed crop of the world after soybean and plam. These are second important oilseed crops of Indian, next to soybean. India is one of the largest rapeseed-mustard growing country occupying first position with 20.23% area and second position with 11.7% share to the global production (Chandra *et al.*, 2013). *Albugo candida* (white rust) is an economically important oomycete pathogen of *Brassica* spp. and other cruciferous species. Infected plants become covered in white, chalky, blister-like pustules, frequently with hypertrophy and distortion of affected tissues. Systemic infection of meristems and inflorescences gives rise to malformed racemes known as stagheads (Petrie, 1973). In India, white rust causes annual yield losses of 17-34% in rapeseed-mustard (Yadava *et al.*, 2011; Pandey *et al.*, 2013).

Observations at the university field experimental station in Pantnagar (northern India) revealed that four genotypes of *B. juncea*, EC-399296, EC-399299, EC-399313 and EC-399301, which showed moderate visible infection with white rust at the cotyledonary leaf stage, showed relatively little or almost no visible infection with this disease at the true-leaf stage (Mishra *et al.*, 2009). Various workers have reported variation in nutrients content in response to the pathogen attack (Singh, 2000; Gupta *et al.*, 1992). Keeping above in view, the present study was carried out to investigate changes in some macro and micronutrients of *B. juncea* genotypes infected with *A. candida*, in addition to another two susceptible varieties, under controlled environmental conditions at the cotyledonary and true-leaf stages.

MATERIALS AND METHODS

Plant material

Six Indian mustard (*B. juncea*) genotypes included in study were two popular Indian cultivars (Kranti and Varuna) and four belonging to accessions classified in three differential resistance groups to downy mildew: EC-399296 [RESBJ-140] was derived from a Chinese accession, Yi Men Feng Wei Zi, EC-399299 [RESBJ-294] and EC-399313 [RESBJ-295] were S 3 lines derived from another Chinese accession, Chang Yang Huang Jie, and EC-399301 [RESBJ-177] was derived from a landrace, BGRC-22527, obtained from Germany (Nashaat *et al.*, 2004). Seedlings of each genotype were raised from untreated seeds in 5-cm-diameter plastic pots placed in a tray (41 × 30 × 7 cm) with each genotype replicated by seven pots. Seeds were sown at approximately 1-cm depth in a mixture of soil + compost +sand (3: 1: 1). The trays were kept in a glasshouse compartment at 16/6°C day/night. Emerged seedlings were thinned to two plants per pot. A separate set of plants were raised for inoculation of true leaves, in 30-cm diameter pots, maintaining eight seedlings per pot with each genotype replicated by seven pots. For each experiment, an

Table 1: Nitrogen content (% dry wt.) in inoculated and un-inoculated cotyledons and true leaves of *B. juncea* genotypes

Genotypes	Cotyledonary stage		True leaves stage 14 DAI		21 DAI	
	I	UI	I	UI	I	UI
Kranti	0.64 (4.58)	0.68 (4.71)	0.78 (5.07)	0.82 (5.18)	0.82 (5.19)	0.85 (5.28)
Varuna	0.66 (4.64)	0.70 (4.81)	0.72 (4.86)	0.77 (5.02)	0.77 (5.02)	0.82 (5.18)
EC-399296	0.56 (4.29)	0.59 (4.41)	0.61 (4.47)	0.67 (4.70)	0.67 (4.69)	0.72 (4.86)
EC-399299	0.49 (4.03)	0.53 (4.16)	0.70 (4.81)	0.74 (4.92)	0.72 (4.86)	0.75 (4.97)
EC-399313	0.51 (4.10)	0.56 (4.29)	0.59 (4.41)	0.66 (4.64)	0.72 (4.86)	0.77 (5.02)
EC-399301	0.58 (4.35)	0.62 (4.53)	0.56 (4.29)	0.62 (4.53)	0.66 (4.64)	0.69 (4.75)
CD (p=0.05)	0.005	0.009	0.004	0.008	0.006	0.01

Figures in parenthesis are angular transformed values; I-Inoculated, UI- Un-inoculated; DAI-Days after inoculation

Table 2: Phosphorus content (% dry wt.) in inoculated and un-inoculated cotyledons and true leaves of *B. juncea* genotypes

Genotypes	Cotyledonary stage		True leaves stage 14 DAI		21 DAI	
	I	UI	I	UI	I	UI
Kranti	0.25 (2.84)	0.34 (3.32)	0.29 (3.13)	0.41 (3.68)	0.31 (3.21)	0.43 (3.76)
Varuna	0.24 (2.82)	0.29 (3.11)	0.26 (2.94)	0.35 (3.41)	0.27 (2.98)	0.37 (3.46)
EC-399296	0.35 (3.39)	0.37 (3.47)	0.40 (3.63)	0.48 (3.98)	0.42 (3.71)	0.51 (4.10)
EC-399299	0.34 (3.36)	0.41 (3.68)	0.39 (3.60)	0.51(4.10)	0.42 (3.69)	0.52 (4.15)
EC-399313	0.36 (3.4)	0.39 (3.59)	0.41 (3.68)	0.49 (4.02)	0.42 (3.70)	0.49 (4.03)
EC-399301	0.36 (3.44)	0.51 (4.10)	0.43 (3.77)	0.61 (4.47)	0.45 (3.85)	0.63 (4.56)
CD (*P*=0.05)	0.002	0.004	0.002	0.003	0.002	0.04

Figures in parenthesis are angular transformed values; I-Inoculated, UI- Un-inoculated; DAI-Days after inoculation

Table 3: Potassium content (% dry wt.) in inoculated and un-inoculated cotyledons and true leaves of *B. juncea* genotypes

Genotypes	Cotyledonary stage		True leaves stage 14 DAI		21 DAI	
	I	UI	I	UI	I	UI
Kranti	1.22 (6.34)	1.05 (5.88)	1.20 (6.28)	1.04 (5.85)	1.19 (6.26)	1.02 (5.79)
Varuna	1.31 (6.57)	1.08 (5.96)	1.27 (6.47)	1.03 (5.82)	1.23 (6.36)	1.02 (5.79)
EC-399296	1.34 (6.64)	1.12 (6.07)	1.30 (6.54)	1.09 (5.99)	1.23 (6.36)	1.04 (5.85)
EC-399299	1.42 (6.84)	1.16 (6.18)	1.39 (6.77)	1.13(6.10)	1.30 (6.54)	1.10 (6.02)
EC-399313	1.38 (6.74)	1.21 (6.31)	1.31 (6.57)	1.15 (6.16)	1.28 (6.49)	1.30 (6.10)
EC-399301	1.41 (6.81)	1.30 (6.54)	1.36 (6.69)	1.22 (6.34)	1.33 (6.62)	1.20 (6.28)
CD (*P*=0.05)	0.03	0.05	0.02	0.03	0.01	0.03

Figures in parenthesis are angular transformed values; I-Inoculated, UI- Un-inoculated; DAI-Days after inoculation

uninoculated set of control comparisons was kept where disease did not appear.

Macro and micronutrient analysis

Samples of inoculated and uninoculated cotyledonary leaves of the six genotypes were collected 14 d.a.i., whereas the true-leaf samples were collected at 14 and 21 d.a.i. Samples were washed with SDW, air-dried and kept in an oven at 60ºC for 48h, then powdered using a mortar and pestle. The powder was packed in three layered polythene bags and stored in a deep freeze at -10ºC to be used later for the estimation of macro and micro-nutrients. Nitrogen was estimated by micro-Kjeldahl method (Thimmaiah, 1999) whereas phosphorus, potassium, zinc and manganese were estimated as per methodology of Jackson (1967).

Statistical analyses

Data obtained in the laboratory experiments were analysed using completely randomized design (CRD). Critical differences were calculated at the 5% probability level of significance for comparison of genotype means.

RESULTS AND DISCUSSION

Nitrogen content was significantly higher in Kranti (0.64, 0.78 and 0.82% dry wt. at cotyledonary, at 14 and 21 DAI, respectively) and Varuna (0.66, 0.72 and 0.77% dry wt. at cotyledonary, at 14 and 21 DAI, respectively) than those of other four genotypes at both the stages of growth. There were significantly higher contents of nitrogen in the uninoculated cotyledons and true leaves of *B. juncea* genotypes and following inoculation with *A. candida,* it decreased in all the genotypes (Table 1). Similar results were obtained by Gupta *et al.* (1984) and Sindhan and Parashar (1996) who reported higher content of nitrogen in the susceptible genotypes which decreased after infection. The significantly higher concentration of phosphorus was recorded in genotype EC-399301 at both the stages (0.36% at cotyledonary stage and 0.43 and 0.45% dry wt at 14 and 21 DAI, respectively) whereas it was significantly lower in Varuna (0.24% at cotyledonary stage and 0.26 and 0.27% dry wt at 14 and 21 DAI, respectively). The present finding is in agreement with the findings of Jaglan and Sindhan (1988). The concentration of phosphorus decreased significantly after infection in all the genotypes irrespective of nature of the reaction of the host plants and this decrease was more pronounced in susceptible genotypes (Table 2). The significantly higher concentration of

Table 4: Zinc content (µg/g dry wt.) in inoculated and un-inoculated cotyledons and true leaves of *B. juncea* genotypes

Genotypes	Cotyledonary stage		True leaves stage 14 DAI		21 DAI	
	I	UI	I	UI	I	UI
Kranti	21.70	24.80	24.30	26.20	26.50	28.25
Varuna	20.80	25.20	23.70	27.10	27.34	30.17
EC-399296	31.50	37.24	33.20	38.10	36.40	40.25
EC-399299	31.36	38.45	34.40	39.20	36.54	41.57
EC-399313	41.28	46.57	42.40	49.50	44.70	50.29
EC-399301	38.50	42.15	40.30	43.70	44.86	54.60
CD (P=0.05)	0.02	0.04	0.05	0.10	0.02	0.04

I-Inoculated, UI- Un-inoculated; DAI-Days after inoculation

Table 5: Manganese content (µg/g dry wt.) in inoculated and un-inoculated cotyledons and true leaves of *B. juncea* genotypes

Genotypes	Cotyledonary stage		True leaves stage 14 DAI		21 DAI	
	I	UI	I	UI	I	UI
Kranti	40.40	54.24	44.10	56.34	44.85	57.20
Varuna	46.06	53.95	49.22	54.67	50.26	54.95
EC-399296	52.25	61.50	54.95	63.28	55.63	64.50
EC-399299	51.54	59.33	55.09	60.24	58.28	62.84
EC-399313	53.71	61.73	57.26	62.83	54.46	67.53
EC-399301	51.55	58.40	60.35	67.50	60.92	69.73
CD (P=0.05)	0.03	0.05	0.03	0.06	0.03	0.04

I-Inoculated, UI- Un-inoculated; DAI-Days after inoculation

potassium was found in uninoculated cotyledons of the genotype EC-399301 (1.30% dry wt) and it increased in all the genotypes significantly after infection, however, its concentration was found to be decreased with increase in age of the host plants (Table 3). The inoculated cotyledons of *B. juncea* genotypes showed lower concentration of Zn in comparison to un-inoculated cotyledons. Significantly higher Zn content was estimated in genotype EC-399313 at cotyledonary stage (41.28 µg/g dry wt), however, at true leaf stage, it was significantly higher in genotype EC-399301 at 21 DAI (44.86 µg/g dry wt) and minimum in Kranti (26.50 µg/g dry wt) (Table 4). Luthra *et al.* (1988) also reported higher content of Zn in downy mildew resistant varieties of *Lucerne*. Similarly, the significantly higher content of Mn was recorded from uninoculated cotyledons of EC-399313 (61.73 µg/g dry wt) and true leaves of EC-399301 (60.92 µg/g dry wt) (Table 5).

High nitrogen content, low zinc and manganese content at cotyledonary stage of genotype EC 399301 perhaps make this genotype to show susceptible type of reaction to white rust whereas low nitrogen, high zinc and manganese content at true leaf stage appear to be an important constituents in imparting resistance to white rust at true leaf stage. Further study in this direction taking a wide range of genotypes possessing differences in reaction to white rust should yield interesting information.

REFERENCES

Chandra, V., Pant, U., Bhajan, R. and Singh, A. K. 2013. Studies on genetic diversity among alternaria blight tolerant Indian mustard genotypes using SSR markers. *The Bioscan*. **8:** 1431-1435.

Gupta, S. K., Kumar, P., Yadava, T. P. and Sachan, G. S. 1984. Changes in phenolic compounds, sugars and total nitrogen in relation to Alternaria leaf blight in Indian mustard. *Haryana Agricultural University J. Research*. **14:** 535-537.

Gupta, S. K., Gupta, P. P., Kaushik, C. D. and Chawla, H. K. L. 1992. Metabolic changes in groundnut leaf due to infection by leaf spot pathogens. *Indian Phytopathology*. **45:** 434-438.

Jackson, M. L. 1967. Soil chemical analysis. *Prentice Hall of India Private Limited,* New Delhi. p. 519.

Jaglan, B. S. and Sindhan, G. S. 1988. Changes in certain mineral elements in tikka resistant and susceptible cultivars of groundnut. *Indian J. Mycology and Plant Pathology*. **18:** 55-56.

Luthra, Y. P., Joshi, U. N., Gandhi, S. K. and Arora, S. K. 1988. Biochemical alterations in downy mildew infected Lucerne leaves. *Indian Phytopathology*. **41:** 100-106.

Mishra, K. K., Kolte, S. J., Nashaat, N. I. and Awasthi, R. P. 2009. Pathological and biochemical changes in *Brassica juncea* (mustard) infected with *Albugo candida* (white rust). *Plant Pathology*. **58:** 80-86.

Nashaat, N. I., Heran, A., Awasthi, R. P. and Kolte, S. J. 2004. Differential response and genes for resistance to *Peronospora parasitica* (downy mildew) in *Brassica juncea* (mustard). *Plant Breeding*. **123:** 512–515.

Pandey, P., Tewari, A. K. and Awasthi, R. P. 2013. Morphological and pathogenic variability of Albugo candida isolates causing white rust in rapeseed-mustard. *The Bioscan*. **8:** 835-838.

Petrie, G. A. 1973. Diseases of *Brassica* species in Saskatchewan, I. Staghead and aster yellows. *Canadian Plant Disease Survey*. **53:** 19, 1970-1972.

Sindhan, G. S. and Parashar, R. D. 1996. Biochemical changes in groundnut leaves due to infection by early and late leaf spot pathogens. *Indian J. Mycology andPlant Pathology*. **26:** 210-212.

Singh, H. V. 2000. Biochemical basis of resistance in Brassica species against downy mildew and white rust of mustard. *Plant Disease Research*. **15:** 75-77.

Thimmaiah, S. K. 1999. Standard methods of biochemical analysis. *Kalyani publishers*, New Delhi. p. 545.

Yadava, D. K., Vignesh, M., Sujata, V., Yadava, A. K., Mohapatra, T. and Prabhu, K. V. 2011. Characterization of Indian mustard (B. juncea) indigenous germplasm line BIOYSR for white rust resistance. *Indian J. Pl. Gen. Reso*. **24:** 400-442.