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Short communication

Influence of soil moisture on growth and nutrient content in healthy and malformed panicles of mango varieties

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ABSTRACT

A field experiment was conducted to study the effect of soil moisture on growth, nutrient status of healthy and malformed panicles of mango varieties. A total of 24 treatment combinations of irrigation and variety were tested in factorial randomized block design with three replications. The results of study revealed that an increase in soil moisture content delayed the bud initiation and panicle emergence. The minimum intensity (2.7 m^2) and severity (24.7%) of malformation was recorded under restricted soil moisture conditions. The higher moisture content in soil increased the intensity (4.5 m^2) and severity (42.7%) of malformation. The higher soil moisture level enlarged the panicles in terms of length (29.5 and 8.6 cm), fresh (37.3 and 70.6 g) and dry weight (21.4 and 28.2 g) of healthy and malformed types, respectively. Higher soil moisture enhanced the foliar contents of N, P, K and Zn in the leaves of healthy panicles and bearing shoots and higher contents of Fe, Mn and Cu in leaves of malformed panicles. Among the varieties minimum malformation intensity (2.9m^{-2}) and severity (25.7%) of was recorded in Langra followed by Amrapali and Sunderja under Jabalpur conditions.

Key words: Soil moisture, malformation, intensity, severity.

At present, mango in India covers 2.50 m ha of area with a total production of 18.0 million tonnes with low average productivity of 7.2 metric tonnes per hectare (Anon, 1). Malformation is the most threatening malady that causes severe economic losses and limits the mango production. The intensity and severity of this disorder are also known to be associated with plant type, season, atmospheric humidity, temperature and status of nutrient and moisture in soil. The moisture stress stimulated growth of floral bud and delayed the vegetative phase. On the other hand, decrease in temperature after moisture stress proved to be beneficial for flower initiation. Presently, there is little information on the soil moisture regime on intensity of mango malformation and its management. Therefore, an attempt has been made to study the effect of status of soil moisture on malformation in different mango varieties.

A field experiment was conducted at Fruit Research Station, Imalia, JNKVV, Jabalpur during 2010 and 2011. The soil of experimental site was clayey in texture (58.4% clay, 22.5% silt and 20.1% sand) having pH 7.2, medium available N (302 kg ha^{-1}), high in P (22.6 kg ha^{-1}) and K (430.7 kg ha^{-1}) with medium organic carbon (0.70%). The experiment consisted of three varieties (V_1: Amrapali, V_2: Sunderja and V_3: Langra) and eight irrigation levels (I_1: control (without irrigation), I_2 : irrigation at 30 days after rains over, I_3 : irrigation at 60 days after rains over, I_4 : irrigation at 90 days after rains over, I_5 : irrigation at 30 and 60 days after rains over, I_6 : irrigation at 30 and 90 days after rains over, I_7 : irrigation at 60 and 90 days after rains over and I_8 : irrigation at 30, 60 and 90 days after rains over). Twenty four plants of each variety were selected randomly and replicated thrice in a factorial randomized block design. Ten branches of each treatment from north, east, west and south direction of plant canopy were tagged randomly and emergence of buds and panicles were recorded. The number of healthy and malformed panicles per m^2 was counted and expressed as intensity and percentage of severity. Tagged shoots were also used to assess panicle length and dry weight accumulation in healthy and malformed panicles. Healthy and malformed panicles were detached separately from node for recording fresh weight. To determine the dry weight, these panicle were chopped and oven-dried (60 ± 2°C) till constant weight. The nutrient content in the shoots bearing healthy and malformed was determined as per standard methods.

Early initiation of bud and emergence of panicles were noted while the plants were not irrigated or irrigation delayed up to 90 days. Moreover, period of bud initiation increased with increase in irrigation frequency, hence moisture stresses encouraged the reproductive phase, *i.e.*, bud initiation as well as emergence of panicles. The present observations was in conformity with the findings of Lu and Chacko (5)

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who reported that soil water deficit promote earlier and more intense flowering in mango. The results of Tahir *et al.* (10) also support the present findings.

After withdrawal of rains, as the number of irrigation was increased the intensity and severity of malformation was also increased. The maximum intensity and severity of malformed panicles (4.5 m^2 and 42.7%) were recorded under higher soil moisture increased through application of three irrigations at an interval of 30 days after rain is over. The least intensity (2.7 m^2) and severity (24.7%) of malformed panicle were noted under without irrigation closely followed by irrigation at 90 days after rains. This might be due to the assimilation of more carbohydrates during moisture stress, which promotes the reproductive phase of plant. These findings are in proximity of Singh and Ram (6), and Gaur and Chakrabarti (4).

The maximum intensity (4.5 m^2), severity (36.0%) and length (9.1 cm) of malformed panicles was recorded in north direction, whereas, minimum intensity (2.7 m^2), severity (27.7%) and length (7.1 cm) of malformed were noted is those in south direction. It was also noted that higher moisture content in soil adversely increased the intensity (4.5 m^2), severity (42.7%) and length (8.6 cm) of malformed panicle. The malformed panicle length and its severity and intensity both increased with the change of direction from south to north. It might be because of higher moisture level, which increased the nutrient uptake. These findings are in agreement with the findings of Gaur and Chakrabarti (4) who reported that the malformation in mango was promoted by high rainfall. Thakur *et al.* (11) found that incidences of floral and vegetative malformation were higher on the north-facing shoots.

Increase in number of irrigation had the positive effect on the number of leaves and panicle length as well as biomass accumulation in healthy and malformed panicles (Table 1). In general, longer healthy panicles with higher fresh and dry weight was noted compared with malformed shoots. The higher number of leaves and longest panicles were recorded under irrigations at 30, 60 and 90 days after rainy season. The increase in number of leaves and length of panicle might be due to the abundant availability of moisture to the plants which might increase the availability of water and solutes for absorption. Results of Singh *et al.* (7) are in the close conformity with present findings.

The intensity and severity of malformation was recorded under different directions of plant canopy (Table 2). Langra was found least susceptible for malformation in terms of intensity (2.2, 2.1, 3.9 and 5.1 m^2) and severity (22.2, 25.0, 26.5 and 29.2%), whereas, Sunderja was the most susceptible recording higher intensity (3.3, 4.3, 5.7 and 5.6 m^2) and severity (33.0, 43.1, 44.6 and 47.4 %) under north, east, west and south directions of plant canopy, respectively. The variation in intensity and severity might be due to genetic constitution of variety. These results are in close agreement with the findings of Thakur *et al.* (11) who also found variety Sunderja to be more susceptible to floral (50.9%) and vegetative (21.3%) malformation. The lowest intensity and severity of malformation in mango variety Langra (9.37%) as also reported by Badiyala and Lakhanpal (2). Whereas, higher severity and intensity of malformation was reported in Amrapali by Gaur and Chakrabarti (4). The higher fresh and dry weight of healthy and malformed panicles was recorded under Sunderja followed by Langra and Amrapali.

Irrigation treatment with different varieties showed variations for intensity and severity of malformation. The higher intensity (5.6 m^2) as well as severity (51.8%) of malformation was recorded when Sunderja plants were irrigated thrice at 30, 60 and 90 days after rains, whereas the lowest incidence was recorded with variety Langra at the same level of soil moisture. These findings are in agreement with the findings of Singh and Ram (6), Badiyala and Lakhanpal (2) and Gaur and Chakrabarti (4). Cultivar Langra was found least susceptible for malformation followed by Amrapali and Sunderja on comparing the canopy in different directions. These findings are in agreement with the findings of Thakur *et al.* (11).

The scheduling of irrigation had marked effect on content of major nutrients (N, P and K) in the leaves of healthy and malformed shoots (Table 3). The significant improvement in nutrient contents was observed with the increasing number of irrigations and reduction in intervals. The three irrigations at 30, 60 and 90 days after the rains recorded the higher content of N (2.72 and 2.47%), P (0.345 and 0.315%) and K (77.1 and 60.71 ppm) in leaves of healthy and malformed bearing shoots, respectively, whereas, it reduced with either the increase in intervals of irrigation or decrease in number of irrigations. Similar observations were recorded by Singh *et al*. (8). The positive relation major nutrient contents with number of irrigations was also noted by Chattopadhyaya and Patra (3). The various varieties did not show marked variations in relation to leaf contents of N, P and K in both healthy and malformed bearing panicle leaves. However, slight variations in healthy and malformed shoots were observed. The results are similar to those of Singh *et al*. (8).

The copper, iron and manganese contents were significantly higher in leaves of malformed shoots as compared to healthy, whereas, zinc content showed the reverse trend (Table 3). These findings are in

Table 1. Influence of soil moisture on growth of healthy and malformed panicles in mango.

Treatment	Bud initiation	Panicle emergence	Panicle length (cm)								Panicle fresh wt. (g)		Panicle dry wt. (g)	
			North		East		West		South					
	(Date/Days)	(Date/Days)	H	M	H	M	H	M	H	M	H	M	H	M
V_1I_1	Jan. 01/76	Jan.15/91	20.5	5.2	21.5	5.0	23.5	6.0	23.8	7.2	19.8	47.7	7.9	21.7
V_1I_2	Jan.01/76	Jan.16/92	23.2	5.9	24.2	5.7	25.8	6.7	25.4	7.9	24.7	50.1	8.7	19.9
V_1I_3	Jan.02/77	Jan.17/93	24.5	6.2	25.5	6.0	26.9	7.0	27.2	8.2	26.3	52.4	9.9	18.4
V_1I_4	Jan.01/76	Jan.16/92	25.3	6.5	26.3	6.3	27.3	7.3	28.3	8.5	27.2	57.7	11.7	19.8
V_1I_5	Jan.02/77	Jan.17/93	25.6	5.9	26.6	5.7	27.6	6.7	29.4	7.9	28.4	59.5	14.9	19.7
V_1I_6	Jan.03/78	Jan.18/94	26.2	5.9	27.2	5.7	28.2	6.7	32.7	7.9	30.4	64.0	15.3	21.5
V_1I_7	Jan.04/79	Jan.19/95	27.4	6.4	28.4	6.2	29.2	7.2	32.7	8.4	28.3	65.3	15.5	22.9
V_1I_8	Jan.05/80	Jan.19/95	29.4	6.7	30.4	6.5	31.4	7.5	33.9	8.7	30.9	67.7	17.1	23.9
Mean	-	-	25.3	6.1	26.3	5.9	27.5	6.9	29.2	8.1	27.0	58.1	12.6	21.0
V_2I_1	Jan.18/94	Feb.08/115	17.8	5.9	18.4	5.7	19.8	6.7	20.5	7.9	27.5	52.8	11.9	29.1
V_2I_2	Jan.20/96	Feb.10/117	19.4	6.9	19.4	6.7	21.4	7.7	23.8	8.9	28.6	58.3	13.3	26.4
V_2I_3	Jan.22/98	Fab.12/119	21.1	7.5	21.1	7.3	23.2	8.3	24.9	9.5	30.8	62.8	15.2	22.9
V_2I_4	Jan.21/96	Feb.09/116	22.7	8.1	22.7	7.9	24.3	8.9	25.3	10.1	32.5	64.4	18.8	24.8
V_2I_5	Jan.23/99	Feb.13/120	23.3	7.2	23.3	7.0	25.4	8.0	25.6	9.2	35.3	65.3	21.7	23.5
V_2I_6	Jan.24/100	Feb.14/121	26.5	7.9	26.5	7.7	28.7	8.7	26.2	9.9	39.2	67.9	23.6	25.8
V_2I_7	Jan.25/101	Feb.15/123	25.7	8.9	26.7	8.7	28.7	9.7	27.2	10.9	38.5	69.8	24.9	30.8
V_2I_8	Jan.25/101	Feb.15/123	27.7	9.1	26.7	8.8	28.9	9.8	29.4	11.1	42.5	75.3	28.5	32.9
Mean	-	-	23.0	7.7	23.1	7.5	25.1	8.5	25.4	9.7	34.4	64.6	19.7	27.0
V_3I_1	Jan 24/100	Feb.14/129	17.4	6.9	17.8	6.7	19.8	7.7	19.8	8.9	21.6	45.7	9.8	26.6
V_3I_2	Jan.26/102	Feb.16/131	22.4	7.5	23.4	7.2	24.3	8.2	25.3	9.5	26.2	48.2	11.2	26.7
V_3I_3	Jan.28/104	Feb.18/133	23.5	7.3	24.5	7.0	25.4	8.0	26.4	9.3	26.6	49.5	12.4	27.9
V_3I_4	Jan.25/101	Feb.14/129	24.0	7.5	25.0	7.3	26.5	8.3	27.5	9.5	29.5	54.8	13.6	27.4
V_3I_5	Jan.27/103	Feb.17/132	23.5	7.9	24.5	7.7	25.4	8.7	26.4	9.9	28.6	50.8	14.2	24.5
V_3I_6	Jan.30/106	Feb.20/135	23.5	7.8	24.5	7.6	25.5	8.6	26.5	9.8	32.5	55.6	15.3	24.2
V_3I_7	Feb.02/109	Feb.22/137	26.8	7.9	27.8	7.8	28.7	8.8	31.7	9.9	34.4	68.1	16.8	26.4
V_3I_8	Feb.04/110	Feb.23/138	26.9	7.9	27.9	7.9	28.9	8.9	32.9	9.9	38.4	68.7	18.7	27.7
Mean	-	-	23.5	7.6	24.4	7.4	25.6	8.4	27.1	9.6	29.7	55.2	14.0	26.4
CD at 5%														
Irrigation (I)			1.64	1.36	2.17	1.32	1.39	1.70	2.06	2.15	2.55	3.11	1.15	3.58
Variety (V)			1.00	0.83	1.33	1.11	NS	1.04	1.26	1.31	1.56	1.90	0.70	2.35
Interaction (I x V)			2.84	2.35	3.77	3.15	2.42	2.95	3.57	3.72	4.42	5.38	2.01	6.67

V_1 : Amrapali, V_2 : Sunderja, V_3 : Langra, I_1 : Control without irrigation, I_2 : Irrigation at 30 days after rains, I_3 : Irrigation at 60 days after rains, I_4 : Irrigation at 90 days after rains, I_5 : Irrigation at 30 and 60 days after rains, I_6 : Irrigation at 30 and 90 days after rains, I_7 : Irrigation at 60 and 90 days after rains, I_8 : Irrigation at 30, 60 and 90 days after rains H : Healthy, M : Malformed panicle.

close conformity with the findings of Singh *et al.* (9), and Singh and Ram (6). The increased in moisture content increased the content of Zn (22.65 to 29.64 and 21.65 to 27.02 ppm), Cu (6.63 to 9.71 and 7.58 to 10.12 ppm) , Fe (137.4 to 196.9 and 154.4 to 210.9 ppm) and Mn (55.1 to 84.5 and 70.1 to 99.5 ppm) in the leaves of healthy and malformed shoots, respectively. It might be due to higher moisture content in soil, which

Table 2. Influence of soil moisture on intensity and severity of healthy and malformed panicles in mango.

Treatment	Intensity (m^{-2})								Severity (%)							
	North		East		West		South		North		East		West		South	
	H	M	H	M	H	M	H	M	H	M	H	M	H	M	H	M
V_1I_1	6.9	1.7	6.9	1.8	7.2	1.8	8.8	2.2	82.7	17.3	77.7	22.3	79.2	20.8	76.3	23.7
V_1I_2	5.1	2.3	6.1	1.9	8.5	3.5	7.9	4.1	76.7	23.3	74.3	25.7	76.4	23.6	74.7	25.3
V_1I_3	4.8	2.3	6.2	1.2	8.1	2.9	6.9	4.5	76.7	23.3	77.7	22.3	73.3	26.7	70.3	29.7
V_1I_4	5.4	1.7	6.5	1.6	7.4	1.9	8.9	2.4	83.3	16.7	77.3	22.7	78.6	21.4	76.7	23.3
V_1I_5	5.2	2.5	7.2	1.8	6.5	7.5	6.2	4.8	74.6	25.4	70.2	29.8	69.3	30.7	67.6	32.4
V_1I_6	4.4	3.7	4.4	2.6	7.7	3.3	5.9	4.6	63.3	36.7	74.3	25.7	71.7	28.3	65.4	34.6
V_1I_7	5.3	3.3	5.3	2.7	6.7	4.3	6.1	4.9	66.7	33.3	67.7	32.3	68.7	31.3	64.6	35.4
V_1I_8	4.5	3.6	4.5	3.5	6.8	5.2	5.9	5.1	53.7	46.3	62.0	38.0	56.7	43.3	53.3	46.7
Mean	5.2	2.7	5.9	2.1	7.4	3.8	7.1	4.1	73.5	26.5	72.7	27.4	71.7	28.3	68.6	31.4
V_2I_1	4.8	2.7	4.8	4.2	7.4	5.6	8.7	4.3	73.3	26.7	65.3	34.7	58.7	36.0	61.7	38.3
V_2I_2	7.2	3.0	6.7	4.1	8.0	7.0	7.2	4.8	70.3	29.7	59.2	40.8	58.3	41.7	57.2	42.8
V_2I_3	7.3	3.3	7.3	4.7	8.0	4.0	6.9	6.1	67.3	32.7	53.5	46.5	66.7	43.3	54.7	45.3
V_2I_4	5.7	2.8	5.7	4.3	7.7	5.4	8.4	5.6	72.5	27.5	65.7	34.3	61.3	38.7	60.7	39.3
V_2I_5	6.5	3.9	6.2	4.0	5.6	6.4	6.7	3.3	61.3	38.7	48.7	51.3	54.7	45.3	52.3	47.7
V_2I_6	3.7	3.5	3.7	4.3	5.9	5.1	6.7	7	64.7	35.3	57.2	42.8	53.3	46.7	50.2	49.8
V_2I_7	4.8	3.5	4.8	4.2	6.8	5.2	5.6	6.4	65.3	34.7	54.6	45.4	51.6	48.4	46.7	53.3
V_2I_8	4.5	3.9	4.5	4.5	5.2	6.8	3.7	7.3	61.2	38.8	55.2	48.8	43.3	56.7	37.3	62.7
Mean	5.6	3.3	5.5	4.3	6.8	5.7	6.7	5.6	67.0	33.0	57.4	43.1	56.0	44.6	52.6	47.4
V_3I_1	5.4	1.3	5.4	1.6	7.3	2.7	8.4	2.3	86.7	13.3	81.7	18.3	79.3	20.7	76.2	23.8
V_3I_2	3.8	2.0	3.8	1.3	8.3	3.8	7.3	3.7	80.5	19.5	77.7	22.3	76.5	23.5	73.7	26.3
V_3I_3	2.9	2.3	2.9	2.1	7.7	2.3	6.3	4.7	77.3	22.7	69.7	30.3	74.7	25.3	71.3	28.7
V_3I_4	5.7	1.5	6.7	1.3	7.2	2.8	8.6	2.5	84.3	14.7	80.3	18.7	78.5	21.5	75.3	24.7
V_3I_5	4.7	2.7	5.7	3.3	7.1	3.9	7.8	5.3	73.3	26.7	67.7	32.3	71.7	28.3	69.3	30.3
V_3I_6	6.9	2.3	6.9	2.1	8.0	3.7	6.5	3.7	76.7	23.3	76.3	23.7	70.3	29.7	69.3	30.7
V_3I_7	6.6	2.7	6.6	2.4	8.1	3.9	6.3	3.7	73.3	26.7	76.3	23.7	69.5	30.5	68.3	31.7
V_3I_8	6.6	3.1	6.6	2.4	9.1	3.9	8.9	5.1	69.3	30.7	69.7	30.3	67.2	32.8	62.3	37.7
Mean	5.3	2.2	5.6	2.1	7.9	3.4	7.5	3.9	77.7	22.3	74.9	25.0	73.5	26.5	70.7	29.2
CD at 5%																
Irrigation (I)	2.7	NS	NS	NS	2.29	1.02	NS	NS	7.87	7.87	9.22	9.29	8.77	8.77	8.65	8.37
Variety (V)	1.6	NS	2.62	0.78	1.40	0.62	NS	0.79	4.82	4.82	5.64	5.69	5.37	5.37	5.30	5.12
Interaction (I × V)	4.7	NS	NS	NS	3.79	1.77	NS	NS	13.6	13.6	NS	NS	15.19	15.19	14.99	14.5

V_1 : Amrapali, V_2 : Sunderja, V_3 : Langra, I_1 : Control without irrigation, I_2 : Irrigation at 30 days after rains, I_3 : Irrigation at 60 days after rains, I_4 : Irrigation at 90 days after rains, I_5 : Irrigation at 30 and 60 days after rains, I_6 : Irrigation at 30 and 90 days after rains, I_7 : Irrigation at 60 and 90 days after rains, I_8 : Irrigation at 30, 60 and 90 days after rains H : Healthy, M : Malformed panicle.

helps the uptake of these nutrients. The increased nutrient content was also reported due to mulching by Chattopadhyaya and Patra (3) in pomegranate.

On the basis of above findings it could be concluded that the initiation of bud and panicle emergence were delayed due to increase in the moisture content.

Table 3. Influence of soil moisture on macro- and micro-nutrient contents in healthy and malformed panicles.

Treatment	Nitrogen (%)		Phosphorous (%)		Potassium (ppm)		Zinc (ppm)		Copper (ppm)		Iron (ppm)		Manganese (ppm)	
	H	M	H	M	H	M	H	M	H	M	H	M	H	M
V_1I_1	1.95	1.83	0.232	0.222	50.09	44.01	22.23	21.23	6.58	7.53	136.1	153.1	56.2	71.2
V_1I_2	2.12	1.86	0.286	0.240	57.25	45.80	23.85	22.85	7.37	8.32	151.9	168.9	68.9	83.9
V_1I_3	2.30	1.93	0.294	0.253	64.40	47.95	24.49	23.19	7.83	8.78	163.1	179.1	67.2	82.2
V_1I_4	2.30	2.08	0.296	0.284	67.06	51.88	25.96	24.69	8.38	9.33	170.4	187.4	68.6	83.6
V_1I_5	2.46	2.27	0.315	0.294	67.37	56.39	26.15	25.45	8.25	9.20	179.4	195.7	70.8	85.8
V_1I_6	2.51	2.37	0.327	0.299	70.87	58.32	27.38	25.74	8.70	9.65	181.9	197.9	75.6	90.6
V_1I_7	2.71	2.46	0.333	0.307	74.37	59.75	28.06	26.36	8.71	9.66	189.4	204.4	80.3	95.3
V_1I_8	2.74	2.49	0.353	0.312	77.86	61.18	29.85	26.99	9.17	10.12	194.9	208.9	83.5	98.5
Mean	2.39	2.16	0.305	0.276	66.16	53.16	26.00	24.56	8.12	9.07	170.9	186.9	71.4	86.4
V_2I_1	1.86	1.81	0.232	0.217	46.51	42.94	22.83	20.83	6.85	7.80	141.9	158.9	57.0	72.0
V_2I_2	2.04	1.92	0.296	0.242	53.67	44.37	23.65	21.65	7.89	8.84	161.0	178.0	68.1	83.1
V_2I_3	2.21	1.97	0.296	0.245	60.83	48.66	23.63	22.63	7.45	8.40	168.2	184.2	71.2	86.2
V_2I_4	2.48	1.99	0.302	0.278	62.38	52.24	25.22	24.72	8.89	9.84	173.3	190.3	77.0	92.0
V_2I_5	2.42	2.23	0.325	0.286	65.78	55.46	26.41	25.64	8.36	9.31	174.9	198.5	77.1	92.1
V_2I_6	2.59	2.30	0.317	0.296	67.69	57.96	27.57	25.97	8.08	9.03	181.0	197.0	78.6	93.6
V_2I_7	2.67	2.36	0.322	0.302	75.67	59.04	28.67	26.17	8.96	9.91	189.7	204.7	80.3	95.3
V_2I_8	2.71	2.44	0.335	0.309	76.91	60.83	29.84	26.84	9.26	10.21	198.9	212.9	88.9	103.9
Mean	2.37	2.13	0.303	0.272	63.43	52.69	25.98	24.31	8.22	9.17	173.6	190.6	74.8	89.8
V_3I_1	2.04	1.85	0.278	0.227	57.25	44.37	22.90	22.90	6.45	7.40	134.3	151.3	52.2	67.2
V_3I_2	2.21	2.04	0.284	0.235	60.83	46.51	23.10	22.19	7.12	8.07	154.3	171.3	54.5	69.5
V_3I_3	2.30	2.01	0.302	0.258	67.98	51.88	23.59	22.99	7.52	8.47	170.9	186.9	68.8	83.8
V_3I_4	2.39	2.02	0.307	0.289	62.99	53.67	25.62	24.52	8.74	9.69	169.4	186.4	72.6	87.6
V_3I_5	2.49	2.27	0.320	0.302	69.60	55.85	26.37	26.17	8.12	9.07	176.8	193.8	71.5	86.5
V_3I_6	2.42	2.28	0.322	0.307	71.82	58.68	27.28	26.28	8.23	9.18	184.5	200.5	72.1	87.1
V_3I_7	2.67	2.38	0.335	0.317	75.00	59.75	28.97	27.16	8.95	9.90	189.4	204.4	78.9	93.9
V_3I_8	2.73	2.47	0.345	0.322	76.27	60.11	29.22	27.22	9.09	10.04	196.8	210.8	81.2	96.2
Mean	2.41	2.16	0.312	0.282	67.72	53.85	25.88	24.93	8.03	8.98	172.0	188.2	69.0	84.0
CD at 5%														
Irrigation (I)	0.075	0.041	0.009	0.006	5.49	1.78	0.676	1.395	2.67	3.58	2.888	3.437	5.645	5.372
Variety (V)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Interaction (I × V)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

V_1 : Amrapali, V_2 : Sunderja, V_3 : Langra, I_1 : Control without irrigation, I_2 : Irrigation at 30 days after rains, I_3 : Irrigation at 60 days after rains, I_4 : Irrigation at 90 days after rains, I_5 : Irrigation at 30 and 60 days after rains, I_6: Irrigation at 30 and 90 days after rains, I_7: Irrigation at 60 and 90 days after rains, I_8: Irrigation at 30, 60 and 90 days after rains H: Healthy, M: Malformed panicle.

Further the restricted moisture minimizes the severity and intensity of malformation. However, higher soil moisture enhanced the content of major (N, P and K) as well as micro-nutrients (Zn, Cu, Fe & Mn) in healthy panicle leaves. Langra variety proved to be relatively resistant to malformation and its severity.

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