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Pre-Flowering Sprays of Zinc and Boron Influenced Panicle Emergence and Panicle Growth of Amrapali Mango

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Abstract

The present investigation was conducted at the instructional farm of Rathindra Krishi Vigyan Kendra under Palli Siksha Bhavana (Institute of Agriculture), Visva Bharati University, Sriniketan which comes under in humid sub-tropical region of West Bengal during the year 2015-16 and 2016-17 to investigate the influence of pre-flowering sprays of zinc and boron on panicle emergence and panicle growth of Amrapali mango. The present study included nine treatment combinations of sprays of zinc sulphate and borax at pre flowering stage replicated three times as T_1: Control (distilled water), T_2: $ZnSO_4$ @ 0.5%, T_3: $ZnSO_4$ @ 1.0%, T_4: Borax @ 0.5%, T_5: Borax @ 1.0%, T_6: $ZnSO_4$ @ 0.5% + Borax @ 0.5%, T_7: $ZnSO_4$ @ 0.5% + Borax @ 1.0%, T_8: $ZnSO_4$ @ 1.0% + Borax @ 0.5% and T_9: $ZnSO_4$ @ 1.0% + Borax @ 1.0% in Randomized Block Design (RBD). The sprays were done in three cycles at 15 days interval starting from end of the November, keeping 3 days gap between zinc sulphate and borax spray in combination treatments. Minimum days to panicle emergence and flowering, maximum panicle length and different types of branches panicle^{-1} were recorded under $ZnSO_4$ @ 1.0% + Borax @ 0.5% spray. In conclusion, $ZnSO_4$ @ 1.0% + Borax @ 0.5% treatment can be used as pre flowering spray for early flowering with better growth of panicles of mango (cv. Amrapali).

Keywords: Boron, Mango, Panicle emergence, Panicle growth, Zinc

Introduction

Mango botanically known as *Mangifera indica L.* belongs to family *Anacardeaceae.* It is one of the predominatnly important fruit crop in the world. It is originated from in Indo Burma region (Bahadur *et al*., 1998) and possesses the delicious quality fruits that rich in vitamins minerals, antioxidants and much more. Due to the abundance the fruit is greatly accessibile to common man most preferred by majority of the populations. The mango has been achieved the status of 'the king of the fruits' in India due to coverage of large area under cultivation ranging from foot hills of Himalayan hills to the near coastal areas (FAO, 2020). It is a tasty and healthy fruit that has long been associated with human culture and religion and is regarded as a crucial element of natural farming. (De, 2022). Mangoes are most famous for its exotic flavours, taste and attractive colour. It ranks fifth after banana, citrus, grape and apple on the basis of production throughout the globe (Merwad *et al*., 2016). Delicious mango pulp is very much enjoyed by people of all age's people. A standard sized mango can supply up to 40% of daily requirement of dietary fibre which helps to protect human from heart disease, cancer and cholesterol related problems. It is also considered as very rich source of potassium, beta-carotene, vitamin C and many other antioxidants (Negi *et al*., 2009).

Inflorescence in mango is called panicle with primary, secondary and sometimes tertiary axes. Panicle is lax to well-filled, small to large, pyramidal to conical, smooth to pubescent in varying extent; coral pink, light green with crimson tinge to different shades of brown, green and yellow. The length of panicle varies from a few centimetres to 60 cm. Mango panicle or inflorescence is primarily terminal but auxillary inflorescence also arise frequently from auxillary buds (Shah *et al*., 2010). The physiological aspects of flowering in mango is a intricate occurrence and it depends on genotypes as well as environmental factors.

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Out of several flushes, flowering occurs after the maturity of a new vegetative flush. Mango flowers come in panicle and there are two types of flowers present in the same panicle, *viz*., hermaphrodite and male flower. A single panicle can bear a good number of flowers that may vary from 1000 to 6000 on the basis of variety or genotypes (Ramirez and Davenport, 2016).

Foliar application of nutrients on fruit trees can quickly help the vegetative growth, flowering, and increase in yield after correcting the deficiency symptoms. It can also improve the fruit size, quality as well as the shelf-life. Judicious and timely application of micronutrients particularly zincs and boron during the growth of flowering flushes and fruits greatly influences flowering and fruit quality. The Zn and B are two very essential micronutrients which play very important role in translocation of assimilates, works as co-factor of various enzymes and their synthesis. Boron plays vital role in development of ovule and growth of pollen tube which ultimately improves the fertilization, fruit set and ultimate yield in mango (Stino *et al*., 2011). Boron is also present in cell membrane and helps for cell division. It also regulates potassium/ calcium ratio in the plant system as well as the absorption of nitrogen and translocation of assimilates. On contrary zinc is one of the vital minor nutrient that has indispensible role in various enzyme associated biochemical reactions and biosynthetic pathways of hormone in plants, *i.e.*, auxin synthesis (Swietlik, 1999). The process of metabolism of protein and carbohydrate is also associated with zinc (Agarwala *et al.*, 1988). Zinc also acts as catalyst in various cellular oxidation-reduction pathways. Severe malformation in mature mango trees has been reported as the cause of zinc deficiency which leads the plants to become unproductive (Kumar and Kumar, 1989).

Nutrients that applied through foliar application absorbed by the leaves very quickly than the soil application and transported to different organs of plant to perform various roles in plant nutrition and growth. It is also considered as one of the ideal method of recovering nutrient deficiency like fertigation (Mahadevan, 2020). A considerable of scientific interventions were attempted earlier to find out the impact of foliar spray of different micro-nutrients in solo or in combination on fruit crops for improvement of flowering, increased fruit set, higher yield and better quality of fruits (Kumari and Deb, 2018; Deb, 2010; Moazzam *et al.*, 2011; Wahdan *et al.*, 2011). Taking into account the aforementioned factors, the current study was carried out to assess the impact of pre-flowering zinc and boron sprays, as well as their combinations, on the flowering behavior of Amrapali mango.

Materials and Methods

Location of Site and Condition

The current study was carried out at the mango orchard situated in the instructional farm of Rathindra Krishi Vigyan Kendra under Palli Siksha Bhavana (Institute of Agriculture), Visva Bharati, Sriniketan, West Bengal comes under the humid sub-tropical region of western part of West Bengal during the year 2015-16 and 2016-17. The location of the experimental site was at about latitude of 23°42' North, longitude of 87°40'30" East and average altitude of 40 m above from mean sea level. The soil texture of the experimental site was loamy sand with near to neutral in reaction (pH of 6.9).

Selection of Plants, Solution Preparation and Spraying

Healthy mature tree of mango trees (cv. Amrapali) was selected from well managed mango orchard. The experiment comprised of 9 treatment combinations of pre-flowering sprays of zinc sulphate and borax replicated 3 times, *viz*., Control (distilled water) as T_1, $ZnSO_4$ @ 0.5% as T_2, $ZnSO_4$ @ 1.0% as T_3, Borax @ 0.5% as T_4, Borax @ 1.0% as T_5, $ZnSO_4$ @ 0.5% with Borax @ 0.5% as T_6, $ZnSO_4$ @ 0.5% with Borax @ 1.0% as T_7, $ZnSO_4$ @ 1.0% with Borax @ 0.5% as T_8 and $ZnSO_4$ @ 1.0% with Borax @ 1.0% as T_9. For preparation of spray solutions $ZnSO_4$ and Borax for different concentrations were measured by the digital weighing balance. $ZnSO_4$ solution is prepared by adding same quantity of lime to adjust the neutral pH. Solution of borax has been prepared by dissolving the borax in hot water followed by cooling. The sprays have been done in three cycles at 15 days interval starting from end of the November keeping 3 days gap between zinc sulphate and borax spray in combination treatments. Randomized Block Design (RBD) was used as statistical design to bring off the current study with nine different treatment combinations and all replicated thrice. Nine trees in each row and such have been selected three rows leaving one row alternatively. Each tree was considered as one replication and thus three trees as one treatment and 27 tree were required for the present experiment.

Observations Recorded

Observations on date to bud bursting from the day of last spray were collected when the bursting took place in the end of first fortnight of February. The date of bursting of each treatment of each replication was collected after 4 days. Then in the beginning of 3rd week of February panicle emergence had been started. Date of half of the total (50%) 0f panicle emergence was collected by calculating the days from the last date of spraying of micronutrients to date of 50% panicle emergence. Date of complete (100%) panicle emergence was collected by counting the days from last date of spraying to duration of panicle emergence. Earliness in flowering (days of 50% flowering) was noted by counting the days from last date of spraying to 50% flowering in one tree. 100% flowering duration was counted by the days from last spray to last date of full bloom of an individual tree. The average length of panicle was collected by taking the length of 3 panicle of each treatment of 3 replications from the base to its tip with the help of a ruler in centimetres. Number of total branches of the panicle was collected by counting the primary, secondary and tertiary branches of single panicle and three panicles of each treatment were counted for getting average.

Data Analysis with Statistics

Data from a variety of observations have been statistically

analyzed using the ANOVA of basic Randomized Block Design, as explained by Gomez and Gomez (1984). Error Mean Square calculation of each parameter were done to test the significance of variance by Fisher Snedecor 'F' test of probability at 0.05% level of significance.

Results and Discussion

Days to Bud Bursting from Last Date of Spraying

Statistical analysis of observations on days to bud bursting from last date of spray as presented in table 1, shows hardly any significance. The bud bursting took maximum days (38.67) from last date of spray in T_6 ($ZnSO_4$ @ 0.5% with Borax @ 0.5%), which is *at par* with T_7 ($ZnSO_4$ @ 0.5% with Borax @ 1.0%); T_9 ($ZnSO_4$ @ 1.0% with Borax @ 1.0%); T_8 ($ZnSO_4$ @ 1.0% with Borax @ 0.5%); T_5 (Borax @ 1.0%); closely followed by T_1 (control). The minimum days (30.33) was observed to bud bursting from the last date of spray in T_4 (Borax @ 0.5%).

Minimum days to bud bursting from last day of spray was observed in single spray of B and closely to control treatment which is perhaps due to the existence of florigenic promoter (FP). Perhaps the florigenic promoter was synthesized in the leaves of mango sprayed with micronutrients as such synthesis is governed by temperature and micronutrient composition of leaves (Sandip *et al.*, 2015). Bud bursting took maximum days under combination treatments or high doses of single treatments may be due to the combination or the high doses of micronutrients suppressed the synthesis of florigenic promoter which suppressed the bursting of new bud. Present finding has the similarity with the report of Banik *et al*. (1997) and Hasani *et al*. (2012).

Days Required for 50% Panicle Emergence

The statistical analysis of the data recorded on days required for 50% panicle emergence is presented in table 1, encompasses the significant variation of spraying micronutrients. Maximum days (58.06) to 50% panicle emergence was noted in T_1 (control) and next by T_6 ($ZnSO_4$ @ 0.5% + Borax @ 0.5%), with 57.23 days; T_4 (Borax @ 0.5%), with 57.18 days and minimum days (43.08) to 50% panicle emergence was recorded in T_8 ($ZnSO_4$ @ 1.0% + Borax @ 0.5%).

Minimum days to 50% panicle emergence was observed under the combination of higher dose of Zn and lower dose of B treatments may be due to the higher auxin production promoted by foliar application of zinc. This higher auxin pool might have promoted the process of division of cell and elongation of cell at apex of shoot. Such higher dispense of assimilates from photosynthesis as well as elevated auxin pool at the shoot apex might have promoted the emergence of panicles in early. Dutta (2004), Razzaq *et al*. (2013), and Singh and Maurya (2004) observed more or less similar findings in mango by application of micronutrients. Sarolia *et al.* (2007) also found corroborated result in guava. Thus these have agreement with the results of current investigation.

Days to 100% Panicle Emergence

Perusal of the observations on total days required for 100% panicle emergence under various treatment combinations of micronutrients as presented in table 1, shows the significant variation. Maximum days required for 100% panicle emergence (71.83) was noted in T_1 (control) and it was statistically *at par* with T_3 ($ZnSO_4$ @ 1.0%), and T_2 ($ZnSO_4$ @ 0.5%), where it was 70.72 days and 70.20 days, respectively. Moreover, minimum days to 100% panicle emergence (52.33) were recorded in T_8 ($ZnSO_4$ @ 1.0% + Borax @ 0.5%).

Combined application of zinc and boron resulted minimum days required to 100% panicle emergence under the current investigation might be attributed to increased growth rate at shoot apex. The similar results were also noted by Sankar *et al*. (2013), Tiwari *et al.* (2017) and Teixeira Lobo *et al*. (2019).

Days to 50% Flowering

In the present experiment the statistical analysis of data recorded on days of 50% flowering from the last date of spray presented in table 1, showed the significant variation. The maximum days to 50% flowering was observed (64.85) days in T_1 (control) and it was statistically similar with T_4 (Borax @ 0.5%) (64.67 days), T_2 ($ZnSO_4$ @ 0.5%) (63.91 days) and T_5 (Borax @ 1.0%) (62.14 days). However, lowest days required to half (50%) flowering (50.55) was noted in T_8 ($ZnSO_4$ @ 1.0% + Borax @ 0.5% spray).

This may be due to enhanced biosynthesis of auxin by foliar application of zinc in the mango plants. Similarly, boron might have regulated cellular metabolism and of carbohydrate translocation as well as cell wall development and nucleic acid synthesis (Anila and Radha, 2003) which further enhanced flowering. The similar results were reported by Ghanta and Mitra (1993), Banik *et al.* (1997), Singh and Maurya (2004), and Jarande *et al*. (2013) in mango, and by Sarolia *et al.* (2007) in guava.

Days to 100% Flowering

Significant variation of days to 100% flowering from last date of spraying presented in table 1 was recorded under different combinations of micronutrient spray, where it was ranged from 66.05 to 79.01 days. The maximum days to 100% flowering was observed in T_2 ($ZnSO_4$ @ 0.5%), with 79.01 days, followed by T_1 (control), with 78.43 days. Minimum days (66.05) to 100% flowering were observed in T_8 ($ZnSO_4$ @ 1.0% + Borax @ 0.5%).

Similar observations were noted by Ahmad *et al*. (2018) when combinations of foliar micronutrient (zinc and boron) application were done in mango plants. Findings of the present investigation have also the agreement with the results as reported by Singh *et al*. (2017).

Average Length of Panicles (*cm*)

The critical examination of the statistically analysed data on the length of the panicles of mango recorded under different combination of micronutrient spray (Table 2) in the present experiment varied significantly. Significantly maximum length recorded in T_8 ($ZnSO_4$ @ 1.0% with Borax @ 0.5%), with the length of 16.83 cm; which was found statistically similar with T_9 ($ZnSO_4$ @ 1.0% with Borax @ 1.0%), with the length of 14.92 cm; followed by T_7 ($ZnSO_4$ 0.5% with Borax 1.0%) with 14.69 cm length. However, the lowest length (10.68 cm) was noted in T_4 (Borax @ 0.5%) and it was noted as *at par* with T_1 (control) with 11.22 cm, T_3 ($ZnSO_4$ @ 1.0%) with 11.34 cm and T_2 ($ZnSO_4$ @ 0.5%) with 11.78 cm.

This might be attributed to the combined implication of zinc and boron that get involved in activation of enzymes associated with growth; synthesis of nucleic acid and protein as well as translocation of assimilates that helped for higher molecular and cellular activity. Zinc-induced auxin biosynthesis might have increased the panicle length of mango by enhancing the cell division and elongation at the apex of the shoot. Higher leaf length was noted by Gurjar *et al.* (2015) under $ZnSO_4$ @ 1.0% + Borax @ 0.5% spray. Similar result was discovered in mango by Dutta (2004), Singh *et al*. (2016), and Singh and Maurya (2004) and by Sarolia *et al.* (2007) in guava, and it is in agreement with the result of the current investigation.

Number of Primary Branches Panicle^{-1}

The perusal data on the number of primary branches panicle^{-1} presented in table 2 reveals that significantly maximum number of primary branches (7.13) were observed under T_8 ($ZnSO_4$ @ 1.0% + Borax @ 0.5%) followed by T_9 ($ZnSO_4$ @ 1.0% with Borax @ 1.0%) (6.81). Additionally, the minimum primary branches panicle^{-1} (4.07) was noted in T_1 (control) and the same was statistically similar with T_5 (Borax @ 1.0%) (5.14), T_7 ($ZnSO_4$ @ 0.5% with Borax @ 1.0%) (5.02 no.), T_3 ($ZnSO_4$ @ 1.0%) (4.33) and T_2 ($ZnSO_4$ @ 0.5%).

Foliar spray of zinc might have triggered the synthesis of auxin and as a result the length of panicle of mango become increased by maximization cell division and other cellular functions in panicle branches caused higher number of primary branches in panicles. Habib *et al*. (2018) has reported increased number of panicle branches of mango by foliar spray of zinc sulphate and borax in combination. Kumar *et al*. (2017) has also reported the similar findings.

Number of Secondary Branches Panicle^{-1}

In the present experiment the statistically analysed data recorded on number of secondary branches panicle^{-1} presented in table 2, encompasses the significant variation of micronutrient spray on flowering of mango tree. Significantly maximum secondary branches panicle^{-1} (12.13) was found in T_8 ($ZnSO_4$ @ 1.0% + Borax @ 0.5%), followed by T_6 ($ZnSO_4$ @ 0.5% + Borax @ 0.5%) (11.02). However, T_1 (control) has exhibited the lowest number of secondary branches (6.03) and that was subsequence of T_2 ($ZnSO_4$ @ 0.5%) (6.22).

Increased production of secondary branches in panicle of mango has stated by Khan *et al*. (2022) by the foliar spray of zinc nutrient along with growth regulators. Similar observations have also been found in the experiment on foliar spray of zinc and boron in solo as well as in combination on Mallika mango as conducted by Kacha *et al.* (2021).

Number of Tertiary Branches Panicle^{-1}

Perusal of the observations on number of tertiary branches panicle^{-1} of mango tree under different combination of micronutrient spray (Table 2) revealed the significant variation. Maximum number of tertiary branches panicle^{-1} (8.78) was observed in T_8 ($ZnSO_4$ @ 1.0% + Borax @ 0.5%) which was closely followed by T_9 ($ZnSO_4$ @ 1.0% + Borax @ 1.0%) (8.23). Significantly minimum number of tertiary branches panicle^{-1} (3.83) was observed under the treatment T_2 ($ZnSO_4$ @ 0.5%), followed by T_1 (control) (4.31).

The result of the present experiment has also agreement with the report of Talang *et al*. (2021), Bhatt *et al.* (2012), and Zagzog and Gad (2017).

Table 1: Effect of pre-flowering spray of micronutrients (zinc and boron) on bud bursting, 50% panicle emergence, 100% panicle emergence, 50% flowering and 100% flowering of mango cv. Amrapali

Treatments		Days to bud bursting from last date of spray	Days to 50% panicle emergence from last date of spray	Days to 100% panicle emergence from last date of spray	Days to 50% flowering from last date of spray	Days to 100% flowering from last date of spray
Notation	Details					
T_1	Control (distilled water)	32.00	58.06	71.83	64.85	78.43
T_2	$ZnSO_4$ 0.5%	30.67	56.08	70.20	63.91	79.01
T_3	$ZnSO_4$ 1.0%	31.67	56.03	70.72	62.82	78.54
T_4	Borax 0.5%	30.33	57.18	65.67	64.67	76.18
T_5	Borax 1.0%	34.67	56.84	64.29	62.14	73.83
T_6	$ZnSO_4$ 0.5% + Borax 0.5%	38.67	57.23	62.04	60.01	70.92
T_7	$ZnSO_4$ 0.5% + Borax 1.0%	38.33	49.20	56.33	55.29	67.44
T_8	$ZnSO_4$ 1.0% + Borax 0.5%	34.67	43.08	52.33	50.55	66.05
T_9	$ZnSO_4$ 1.0% + Borax 1.0%	35.67	45.33	56.37	53.61	69.17
	S.Em. (±)	2.38	2.86	2.74	1.62	1.41
	CD	NS	4.92	5.68	3.33	2.63

[NS: Non-significant]

Table 2: Effect of pre-flowering spray of micronutrients (zinc and boron) on average length, primary, secondary and tertiary branches of panicles of mango cv. Amrapali

Treatments		Average length of panicle (cm)	No. of primary branches panicle^{-1}	No. of secondary branches panicle^{-1}	No. of tertiary branches panicle^{-1}
Notation	Details				
T_1	Control (distilled water)	11.22	4.07	6.03	4.31
T_2	$ZnSO_4$ 0.5%	11.78	4.27	6.22	3.83
T_3	$ZnSO_4$ 1.0%	11.34	4.33	6.84	5.50
T_4	Borax 0.5%	10.68	5.39	9.17	5.44
T_5	Borax 1.0%	12.76	5.14	10.07	7.20
T_6	$ZnSO_4$ 0.5% + Borax 0.5%	13.19	5.65	11.02	6.13
T_7	$ZnSO_4$ 0.5% + Borax 1.0%	14.69	5.02	10.50	6.56
T_8	$ZnSO_4$ 1.0% + Borax 0.5%	16.83	7.13	12.23	8.78
T_9	$ZnSO_4$ 1.0% + Borax 1.0%	14.92	6.81	10.11	8.23
	S.Em. (±)	1.09	0.60	0.73	0.50
	CD	2.46	1.24	2.12	1.45

Conclusion

Pre-flowering spray of different combinations of micronutrients like zinc as zinc sulphate and boron as borax on Amrapali mango has significantly influenced the panicle characteristics (earliness in panicle emergence, length of panicle, primary, secondary and tertiary branches panicle^{-1}), *etc*. Minimum days to panicle emergence and flowering, maximum length of panicle, highest number of different types of branches panicle^{-1} was recorded under $ZnSO_4$ @ 1.0% + Borax @ 0.5% spray. Thus, based on the result of the current investigation, consequently it may be said that $ZnSO_4$ @ 1.0% with Borax @ 0.5% treatment can be used as pre flowering spray for early flowering with better growth of panicles of mango (cv. Amrapali).

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