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## Diagnosis of Boron Deficiency as a Cause of Flower Abortion and Failure of Pod Set in Chickpea in Nepal

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Flower and pod drop is an important production constraint of chickpea in Chitwan, Nawalparasi, Makwanpur, and Bara districts in Nepal. The problem was first observed on the experimental station of the Grain Legumes Research Program, Rampur, Chitwan, Nepal, both in chickpea and lentil. Observations on farmers' fields suggested that the problem was not confined to the experimental station alone. Genotypic differences in aborting of flowers and failure of pod set were observed in both these crops. Landraces—Dhanush in chickpea and Simal in lentil—did not show this problem, whereas most of the bred cultivars did.

It is known that botrytis gray mold (*Botrytis cinerea*) (Nene and Reddy 1987) and low temperatures (Saxena and Johansen 1990) cause flower abortion and failure of pod set in chickpea. At Rampur, however, flower abortion appeared to be occurring independent of botrytis gray mold (M P Haware, IAC, personal communication), and minimum temperatures rarely fall below the critical limit of 5–8°C (Saxena and Johansen 1990).

Soils of Chitwan Valley seem to have a complex problem of nutrient deficiencies (Khatri-Chhetri 1982). Soils at Rampur are sandy loams and chemical analysis indicated low pH (6.2) and low levels of secondary and micronutrients. Symptoms on other crops in the region, such as spikelet sterility in wheat, and rosetting in radish and cabbage, suggested boron (B) as a probable factor involved in the abortion of flowers, and failure of pod set in chickpea. Preliminary experiments conducted on the experimental station, Rampur, showed that foliar application of B increased number of pods plant$^{-1}$ and grain yield significantly in a susceptible chickpea variety, Kalika, over the control (Srivastava 1994).

To further establish that B deficiency was the major factor involved in flower abortion and failure of pod set, a field trial was conducted at the Agricultural Research Station, Rampur, during 1994/95. A subtractive design was used, testing the effect of omission of nutrients that could possibly be deficient (see Table 1 for the treatments). Nitrogen was not included as a treatment as plants were *Rhizobium* dependent. Lime was applied 4 days before sowing, and all other nutrients were broadcast as a basal application, and mixed in the 0–15 cm soil surface layer. Kalika, a chickpea variety susceptible to flower abortion, was sown on 26 Nov 1994 in rows 30-cm apart and at a plant-to-plant spacing of 15 cm. Plot size was 1.8 × 2.1 m. Treatments were laid out in a randomized block design with 4 replications. Two seeds hill$^{-1}$ were sown, and seedlings were thinned to one plant hill$^{-1}$ at 15 days after emergence.

Number of aborted flowers and number of pods plant$^{-1}$ were recorded at 104, 108, and 112 days after sowing (DAS). At maturity (131 DAS) plant stand was recorded, and plants were harvested from 0.72 m$^2$ for recording shoot mass and yield and yield components.

In the treatment without B (-B) the number of aborted flowers was highest, followed by the control (Table 1). Very few aborted flowers were observed in the other treatments. The greater flower abortion in the -B treatment, compared to the control, may perhaps be because the effect of B deficiency was accentuated when other nutrients were not limiting. Growth of the plants in the -B treatment was better compared to the control, perhaps because the additional nutrients in the -B treatment aggravated the effect of B deficiency on flower abortion. No pods were produced in the -B treatment, and only one pod plant$^{-1}$ in the control and 7 pods plant$^{-1}$ in the treatment without Molybdenum (-Mo) were recorded. The other treatments produced 10–14 pods plant$^{-1}$. In the control treatment no grain was formed in the pods produced. The -Mo treatment had 3 filled pods plant$^{-1}$ while the remaining treatments had between 5–6 filled pods plant$^{-1}$. Pod and grain yield plot$^{-1}$ followed trends similar to number of filled pods (Table 1).

These results conclusively indicate that B deficiency is the primary causal factor for flower and pod drop in chickpea at Rampur. Molybdenum also seems to be de-

**Table 1. Effect of the treatments on the flower drop plant$^{-1}$ (at 111 days after sowing), total pods plant$^{-1}$, filled pods plant$^{-1}$, pod yield plot$^{-1}$, grain yield plot$^{-1}$, and 100-seed mass (at harvest), Rampur, Nepal, 1994/95.**

| Treatments[1] | Dead flowers per plant[2] | Total pods per plant[3] | Filled pods per plant[3] | Pod yield (g plot$^{-1}$) | Grain yield (g plot$^{-1}$) | 100-seed mass (g) |
|---|---|---|---|---|---|---|
| Control (no nutrients applied) | 15 c[4] | 1 b | 0 a | 9.6 a | 2.7 a | Only a few grains |
| Complete (P, K, S, B, Zn, Mo, Cu, Mn, and Fe) | 2 b | 13 e | 6 d | 174.7 cd | 112.8 cde | 16.5 b |
| Complete-B | 31 d | 0 a | 0 a | 0.0 a | 0.0 a | No grains |
| Complete-Zn | 2 b | 14 f | 6 d | 195.6 de | 126.6 e | 16.2 b |
| Complete-Mo | 2 b | 7 c | 3 b | 99.3 b | 67.0 | 14.0 a |
| Complete-Fe | 2 b | 10 d | 5 c | 163.8 c | 109.0 cd | 15.3 b |
| Complete-(Cu+Mn) | 1 a | 14 f | 6 d | 214.6 e | 143.6 f | 18.2 c |
| Complete-(K+S) | 2 b | 10 d | 5 c | 150.5 c | 102.3 c | 13.9 a |
| Complete+Lime | 1 a | 13 e | 6 d | 189.8 de | 125.3 de | 16.9 b |
| SE | ±1 | ±1 | 0 | ±8.2 | ±5.4 | ±0.42 |
| F. Test[5] | *** | *** | *** | *** | *** | *** |
| CV (%) | 23.0 | 12.0 | 18.6 | 12.0 | 12.0 | 5.0 |

1. Rates of nutrients applied (kg ha$^{-1}$): P = 25; K = 50; S = 20; B = 0.5; Zn = 2.5; Mo = 0.15; Cu = 2.5; Mn = 2.5; Fe = 2.5; Ca (as lime) = 1200.
2. Mean of 5 plants and 4 replications.
3. Mean of 16 plants and 4 replications.
4. *** Significantly different at $P = 0.001$.
5. Means followed by the same letter(s) within a column are not significantly different from each other at the 5% level of significance, according to Duncan's Multiple Range Test.

ficient. Pod filling was not perfect in +B and +Mo treatments, suggesting that the requirements for these two elements were not completely met from the amount applied as treatments. A trial with different levels of B and Mo has been sown during the 1995/96 season to investigate and further confirm that B is the causal factor in flower abortion and failure of pod set in chickpea. Multilocation on-farm trials are also being conducted, to assess the extent of these nutrient deficiencies.

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