

## Effect of integrated nutrient management in maize (*Zea mays*) on succeeding winter crops under rainfed conditions

J.S. JAMWAL

Dryland Research Substation, Sher-e-Kashmir University of Agricultural Sciences and Technology, Rakh Dhiansar, Bari-Brahmana, Jammu & Kashmir 181133

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### ABSTRACT

A field experiment was conducted during rainy (*kharif*) and winter (*rabi*) seasons of 1998-99 and 1999-2000 at Dryland Research Substation, Rakh Dhiansar, Bari-Brahmana, to evaluate the residual effect of integrated nutrient management in maize (*Zea mays* L.) on succeeding *gobhi sarson* (*Brassica napus* L.) and chickpea (*Cicer arietinum* L.). Application of recommended dose of NPK (60:40:20 kg/ha) + 20 kg ZnSO<sub>4</sub>/ha during *kharif* significantly increased the grain yield of maize as well as the succeeding crops of *gobhi sarson* and chickpea. Application of farmyard manure (FYM) significantly increased the available N, P and K status of the soil after maize harvest. Available P status of the soil after the harvest of *gobhi sarson* and chickpea also increased significantly due to the residual effect of FYM and fertility levels.

**Key words:** Residual effect, Fertility, FYM, *Gobhi sarson*, Chickpea, Cropping system

The responses of the succeeding crops in a cropping system are influenced greatly by the preceding crops and the inputs applied therein. Therefore recently greater emphasis is being laid on the cropping system as a whole rather than on the individual crops in a sequence. Organic manures and phosphatic fertilizers have carry-over effect on the succeeding crops. Less than 30% of the applied nitrogen and a small fraction of phosphorus and potassium in inorganic fertilizers may become available to the immediate crop and the rest to the subsequent crops. Maintenance of soil fertility is important for obtaining higher and sustainable yield due to large turnover of plant nutrients in the soil-plant system. Since the information on the residual effect of integrated nutrient supply system on succeeding crops of *gobhi sarson* (*Brassica napus* L.) and chickpea (*Cicer arietinum* L.) after maize under dryland conditions in this region is lacking, the present study was conducted to assess the effectiveness of residual effect of FYM, crop residues and inorganic fertilizers applied in *kharif* on soil fertility and yield of *gobhi sarson* and chickpea.

### MATERIALS AND METHODS

A field experiment was conducted during 1998-99 and 1999-2000 at Dryland Research Substation, Rakh Dhiansar, Bari-Brahmana, to work out the residual effect of organics and inorganics applied in maize during *kharif* on the succeeding mustard and chickpea. The soil was sandy loam, having pH 6.5, low in organic carbon

(0.35%), and available N (210 kg/ha), P (20 kg/ha) and K (115 kg/ha). There were 10 treatments, viz. T<sub>1</sub>, control; T<sub>2</sub>, recommended dose of NPK (60:40:20 kg/ha); T<sub>3</sub>, half of recommended NPK (N<sub>30</sub>P<sub>20</sub>K<sub>10</sub>); T<sub>4</sub>, half of recommended NPK through crop residues; T<sub>5</sub>, half of recommended N through farmyard manure (FYM); T<sub>6</sub>, half of recommended NPK + half N through crop residues; T<sub>7</sub>, half of recommended NPK + half N through FYM; T<sub>8</sub>, 10 tonnes FYM/ha; T<sub>9</sub>, recommended NPK + 20 kg ZnSO<sub>4</sub>/ha; and T<sub>10</sub>, farmer's method (4 tonnes FYM + 40 kg urea/ha). The treatments were replicated thrice in randomized block design. Maize 'GS 2' was sown during *kharif*. After maize harvest, *gobhi sarson* 'GSL 2' and chickpea 'PBG 1' were raised on residual soil fertility. *Rabi* crops were sown in the first fortnight of October and harvested during end of March every year. Available N, P and K content in the soil at 0–15 cm depth from each plot after maize and *gobhi sarson* and chickpea harvest were estimated. A total rainfall of 746 and 772.2 mm was received in 48 and 47 rainy days during *kharif* 1998 and 1999 respectively, and 122.8 and 234.2 mm rainfall in 22 and 17 rainy days during *rabi* in these years.

### RESULTS AND DISCUSSION

#### Grain yield of maize

The grain yield of maize was the highest with the application of recommended dose of NPK through inorganic fertilizers along with 20 kg ZnSO<sub>4</sub>/ha. However, this was

on a par with the grain yield obtained with the application of recommended NPK only. It decreased significantly on reduction in the recommended fertility level. Bajpai *et al.* (2002) reported similar results in rice. Substitution of half the recommended N through crop residues also significantly lowered the grain yield of maize compared with the substitution of N through FYM.

The grain yields obtained with half the recommended N through FYM, half the recommended NPK + half the N through crop residues and farmer's method were comparable with each other. The application of organics in these methods might have exerted favourable effect on the chemical, physical and biological properties of the soil. Patidar and Mali (2002) reported similar observations in sorghum. The grain yield with 10 tonnes FYM/ha and half the recommended N + half N through FYM were at par. Half the recommended N through FYM, half the recommended NPK + half N through crop residues and farmer's method recorded almost similar increase in grain yield over the control.

#### Soil fertility after maize harvest

The application of FYM had significant effect on the available NPK status of the soil after maize harvest. The increased availability of these nutrients in soil might be due to their subsequent release from FYM. These results confirm the findings of Vaidya and Gabhane (1998) and

Patidar and Mali (2002).

The available N status of the soil after maize harvest was significantly affected by fertility levels. The highest amount of available N was observed under 10 tonnes FYM/ha, followed by half the recommended N + half N through FYM, recommended NPK + 20 kg ZnSO<sub>4</sub>/ha and recommended NPK levels. Available N status of the soil after maize harvest was almost similar under half the recommended NPK levels and half the recommended N through FYM, half the recommended N through crop residues and farmer's method.

Maximum available P after maize harvest was observed in 10 tonnes FYM/ha, followed by recommended NPK + 20 kg ZnSO<sub>4</sub>/ha and recommended NPK. The improvement in available P status of the soil might be due to build up of phosphorus in the soil owing to addition of P through these treatments. The available P status in the soil after maize harvest was almost similar under half the recommended N through crop residues, half the recommended NPK, half the recommended N through FYM, half the recommended N + half N through crop residues and half the recommended N + half N through FYM.

The fertility levels showed significant variations in the available K status in soil after maize harvest. Maximum available K was observed in 10 tonnes FYM/ha, closely followed by recommended NPK + 20 kg ZnSO<sub>4</sub>/ha and recommended NPK. The available K status of the soil after

**Table 1.** Effect of FYM, organic wastes and fertility levels on grain yield of maize and chickpea and oilseed yields of gobhi sarson, and soil-fertility status (mean data of 2 years)

| Treatment                                                                    | Maize-grain<br>yield (q/ha) | Available nutrients<br>after maize (kg/ha) |      |       | Grain or<br>oilseed yield<br>(q/ha) |                 | Gobhi sarson-<br>equivalent<br>yield (q/ha) | Available<br>nutrients<br>(kg/ha) |      |       |
|------------------------------------------------------------------------------|-----------------------------|--------------------------------------------|------|-------|-------------------------------------|-----------------|---------------------------------------------|-----------------------------------|------|-------|
|                                                                              |                             | N                                          | P    | K     | Chick-<br>pea                       | Gobhi<br>sarson |                                             | N                                 | P    | K     |
|                                                                              |                             |                                            |      |       |                                     |                 |                                             |                                   |      |       |
| Control                                                                      | 13.84                       | 192.3                                      | 16.4 | 105.3 | 1.60                                | 5.57            | 7.97                                        | 191.5                             | 14.8 | 103.2 |
| Recommended NPK levels<br>(N <sub>40</sub> P <sub>60</sub> K <sub>20</sub> ) | 31.83                       | 225.6                                      | 28.2 | 118.5 | 2.03                                | 10.40           | 13.45                                       | 200.2                             | 25.2 | 115.3 |
| Half the recommended NPK                                                     | 20.49                       | 210.2                                      | 22.6 | 110.3 | 1.80                                | 9.68            | 12.38                                       | 205.4                             | 20.1 | 107.2 |
| Half the recommended NPK<br>through crop residues                            | 16.58                       | 204.3                                      | 23.2 | 112.5 | 1.88                                | 11.78           | 14.60                                       | 206.1                             | 21.3 | 109.4 |
| Half the recommended<br>N through FYM                                        | 22.93                       | 210.5                                      | 22.4 | 110.4 | 2.16                                | 11.85           | 15.09                                       | 208.3                             | 21.2 | 107.5 |
| Half the recommended NPK +<br>half N through crop residues                   | 23.76                       | 226.8                                      | 22.3 | 116.3 | 2.16                                | 10.23           | 13.47                                       | 207.5                             | 19.7 | 109.1 |
| Half the recommended N<br>+ half N through FYM                               | 27.32                       | 229.6                                      | 21.8 | 109.4 | 3.41                                | 12.20           | 17.32                                       | 206.8                             | 20.7 | 107.2 |
| 10 t FYM/ha                                                                  | 28.80                       | 230.8                                      | 29.6 | 121.3 | 3.49                                | 12.86           | 18.10                                       | 207.6                             | 26.1 | 118.4 |
| Recommended NPK +<br>20 kg ZnSO <sub>4</sub> /ha                             | 32.80                       | 226.8                                      | 28.3 | 120.4 | 2.16                                | 9.78            | 13.02                                       | 205.4                             | 25.2 | 118.2 |
| Farmer's method<br>(4 t FYM + 40 kg urea/ha)                                 | 23.74                       | 200.3                                      | 17.8 | 108.1 | 3.36                                | 8.93            | 13.82                                       | 195.6                             | 16.6 | 105.1 |
| CD (P=0.05)                                                                  | 3.2                         | 8.56                                       | 1.5  | 2.9   | 0.56                                | 1.91            | 1.80                                        | NS                                | 0.81 | 3.2   |

maize harvest was similar under half the recommended N through crop residues, half the recommended NPK, half the recommended N through FYM and half the recommended N + half N through FYM.

### **Chickpea and gobhi sarson yields**

The grain yield of chickpea was the highest with the application of 10 tonnes FYM/ha in the preceding maize, followed by half the recommended N + half N through FYM and farmer's method. All other treatments were on a par with each other in this respect. Almost similar trend was observed in the oilseed yield of *gobhi sarson* also.

### **Gobhi sarson-equivalent yield**

The *gobhi sarson*-equivalent yield of chickpea and *gobhi sarson* was highest with the application of 10 tonnes FYM/ha in the preceding maize. However, it was on a par with the mustard-equivalent yield obtained with half the recommended N + half N through FYM. The mean *gobhi sarson*-equivalent yield was also higher with the application of treatments involving FYM. *Gobhi sarson*-equivalent yields obtained with the recommended NPK, half the recommended NPK + half the N through crop residues and recommended NPK + 20 kg ZnSO<sub>4</sub>/ha were at par. Application of half the recommended NPK in the preceding season gave the least advantage in increasing the *gobhi sarson*-equivalent yield of chickpea and *gobhi sarson*.

### **Soil fertility after chickpea and gobhi sarson**

Application of FYM, inorganic fertilizers and crop residues in the rainy season did not influence the available N status of the soil after the harvest of *gobhi sarson* or chickpea (Table 2). However, available soil-P status was significantly influenced by FYM and fertility levels. It was found that the mean available P after chickpea and *gobhi sarson* harvest was the highest with 10 tonnes FYM/ha, closely followed by recommended NPK + 20 kg ZnSO<sub>4</sub>/ha and the recommended NPK. This increase in available

P status of the soil might be due to favourable effect of FYM and the residual effect of applied fertilizers. Patidar and Mali (2002) found similar results. Sahrawat *et al.* (1995) reported that P applied in previous years was 58% effective as fresh P on Vertisols.

Significant variation in available K status of the soil after the harvest of chickpea and *gobhi sarson* was also observed due to different fertility levels. Maximum available soil K was observed under 10 tonnes FYM/ha, closely followed by recommended NPK + 20 kg ZnSO<sub>4</sub>/ha and the recommended NPK. The available soil-K status after *rabi* crop harvest was almost the same under half the recommended N through crop residues, half the recommended N through FYM, half the recommended NPK and half the recommended N + half N through FYM.

It was concluded that application of 10 tonnes FYM/ha and recommended dose of NPK to maize during *kharif* had significant residual effect on the succeeding crops of chickpea and *gobhi sarson*.

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