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Effect of different levels of nutrients under drip fertigation on protein content in grain, protein yield and production efficiency of maize in maize - Gobhi sarson cropping system

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Abstract
Experiments were conducted during *kharif* 2018 and 2019 at Instructional cum Research Farm, Indira Gandhi Krishi Vishwavidyalaya Raipur (C.G.). The soil of experimental field was clayey (*Vertisols*) in texture, locally known as "*Kanhar*" which was low, medium and high in available N, P_2O_5 and K_2O, respectively. The experiment was laid out in randomized block design with three replications and eight treatments. The treatment consisted of maize crop T_1- Drip fertigation with 75% RDF, T_2- Drip fertigation with 100% RDF, T_3- Drip fertigation with 125% RDF, T_4- Drip fertigation with 150% RDF, T_5- Drip fertigation with 175% RDF, T_6- Soil application of 25% RDF and Drip fertigation with 75% RDF, T_7- Soil application with 100% RDF and Drip irrigation, and T_8- No fertilizer and surface irrigation. The total uptake of nitrogen (160.57 kg ha^{-1}), phosphorus (76.27 kg ha^{-1}) and potassium (146.41 kg ha^{-1}) were recorded highest with the treatment of drip fertigation with 175% RDF, Which was significantly superior to others, but it was statistically at par to the treatments of T_3:125% RDF T_4:150% RDF during both the years and on mean basis. However, drip fertigation with 175% RDF found higher protein content in grain, protein yield and production efficiency during both the years and on mean basis.

Keywords: Ertigation, protein, grain, potassium

Introduction
India is a land of multiplicity of cropping system and pattern, where more than 30 different types of cropping systems are being adopted in different regions of the country. The dominant cropping systems are rice- wheat, rice-mustard, maize-gram, and soybean-wheat. In Chhattisgarh during rainy season, rice is the predominant crop and rice based cropping systems are generally practiced by the farmers of the state. With the increase in awareness about modern and profit oriented agriculture, diversification is taking place in large scale and maize is being widely adopted by the farmers during rainy season. Farmers are also looking for productive and remunerative crops during winter season. In this regards, an emerging cropping system consisting of maize-gobhi sarson appears to be suitable option for the farmers of Chhattisgarh plains.

Maize (*Zea mays L.*) is one of the most crucial and strategic crop in the world. Maize plays a vital role in ensuring food security as well as nutritional security through quality protein. This crop has immense potentiality with special characteristics that include its carbon pathway (C_4), wider adaptability, higher multiplication ratio, high yielding ability and high versatile use, therefore called as "Queen of Cereals". The United States of America (USA) is the largest producer of maize and contributes nearly 35 per cent of the total production in the world. In India, maize is the third most important food crop after rice and wheat. In India, it is cultivated over an area of 7330.57 thousand ha with production of 19413.60 thousand tonnes and productivity of 2648 kg ha^{-1} (Anonymous, 2018-19) [1]. In Chhattisgarh, maize is grown during rainy as well as in winter season. During rainy season, it occupies an area of 226.79 thousand ha with the productivity of 2458 kg ha^{-1}, while in winter season it is grown on 74.45 thousand ha with productivity of 1950 kg ha^{-1} (Krishi Darshika, 2019) [3].

Oilseed crops play an important role in agriculture as well as economy of the country). Rapeseed and mustard is the third most important edible oilseed crop of the world after soybean (*Glycine max*) and palm oil (*Elaeis guineensis J acq*.).

In India, area, production and productivity of Rapeseed-mustard was 6123.93 thousand ha, 9255.66 thousand tonnes and 1511 kg ha^{-1}, respectively (Anonymous, 2018-19) [1]. In Chhattisgarh, area and productivity of rapeseed-mustard was 157.67 thousand ha, and 564 kg ha^{-1} (Krishi Darshika, 2019) [3], respectively.

The introduction of drip with fertigation, may inhance crop yield many times from the same quantity of water. Due to increasing the use efficiency of nitrogen, phosphorus and potassium to the extent of 95, 45 and 80 percent, respectively (Satisha, 1997) [4].

When fertilizer is applied through the drip, besides the yield increase, about 30 per cent fertilizer could be saved (Sivanappan and Ranghaswami, 2005) [5]. Drip fertigation improves crop productivity by 60-100 per cent (Sritharan, 2010) [6]. The major benefits of the system is the water use efficiency, which is as higher as 90-95 per cent compared to only about 25-30 per cent in the conventional furrow or flooding irrigation.

Materials and methods

Protein content (%) and protein yield (kg ha^{-1})

The protein content was computed by multiplying the respective nitrogen content of grain by the constant of 6.25 and then protein yield was worked out using the following formula:

Protein yield (kg ha^{-1}) = Grain yield (q ha^{-1}) × Protein content in grain

Production efficiency

Production efficiency was calculated with the help of following formula given by Tomar and Tiwari (1990):

$$\text{Production efficiency (kg ha}^{-1}\text{ day}^{-1}\text{)} \; \frac{\text{Grain yield (kg ha}^{-1}\text{)}}{\text{Duration of the crop}}$$

Results and discussion

Protein content in grain (%), protein yield (kg ha^{-1})

The data on protein content in grain, and protein yield of maize as influenced by different levels of nutrients under drip fertigation presented in (Table1).The results revealed that the different levels of nutrients under drip fertigation significantly higher protein content in grain were registered under treatments of drip fertigation with 175% RDF which was found at par to treatments drip fertigation with 100% RDF, 125%RDF and 150% RDF during both the years and on mean basis. As regards to protein yield, significantly higher protein yield of maize was also registered under treatment of drip fertigation with 175% RDF, which was found at par to treatments drip fertigation with 125% RDF and 150% RDF on mean basis. The lowest protein content and yield was obtained under the treatment of no fertilizer and surface irrigation during both the years and on mean basis. The protein content of the grain was decided by the nitrogen content of the grain, however increased nitrogen content in grain enhanced the protein content of the grain as also reported by Peric *et al.* (2009) [7] and Morshed *et al.* (2008) [8]. Since the fertigation dose was higher and sufficient under 175 per cent RDF, it might have resulted in higher uptake of nitrogen and ultimately resulted in higher protein content of maize similar results were reported Rajwade *et al.* (2018) [9] and Fanish (2013) [2].

Production efficiency

The data on production efficiency of maize as influenced by different levels of nutrients under drip fertigtion are presented in Table 4.18.The results revealed that the different levels of nutrients under drip fertigtion significantly higher production efficiency were registered under treatments of drip fertigation with 175% RDF which was found at par to treatments drip fertigation with 100% RDF, 125% RDF and 150% RDF during both the years and on mean basis. The increase in production efficiency was due to enhanced grain yield under different treatments.

Table 1: Protein content in grain, protein yield and production efficiency of maize as influenced by different levels of nutrients under drip fertigation in maize- gobhi sarson cropping system

Treatment	Protein content in grain (%)			Protein yield (kg ha^{-1})			Production efficiency (kg ha^{-1} day^{-1})		
	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean
T_1- Drip fertigation with 75% RDF	7.81	7.90	7.85	492.13	465.45	478.79	55.75	51.25	53.50
T_2- Drip fertigation with 100% RDF	7.91	8.00	7.95	566.85	544.02	555.44	63.43	59.04	61.24
T_3 - Drip fertigation with 125% RDF	7.98	8.06	8.02	592.69	552.65	572.67	65.73	59.59	62.66
T_4- Drip fertigation with 150% RDF	8.06	8.13	8.09	609.92	581.66	595.79	67.55	62.26	64.91
T_5- Drip fertigation with 175% RDF	8.08	8.14	8.11	630.11	606.44	618.27	68.99	64.75	66.87
T_6- Soil application of 25% RDF and drip fertigation with 75% RDF	7.83	7.90	7.86	521.52	502.84	512.18	60.05	55.39	57.72
T_7- Soil application of 100% RDF and drip irrigation	7.75	7.79	7.77	443.04	488.92	465.98	50.60	54.60	52.60
T_8-No fertilizer and surface irrigation	7.63	7.36	7.49	155.40	145.74	150.57	18.81	17.10	17.96
SEm±	0.07	0.07	0.06	22.11	20.35	16.30	2.6	2.1	2.27
CD(P=0.05)	0.22	0.21	0.17	67.07	61.73	48.98	7.89	6.45	6.87

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