Biotechnology in Animal Husbandry 21 (5-6), p 193-196, 2005 ISSN 1450-9156
Publisher: Institute for Animal Husbandry, Belgrade-Zemun UDC: 633.3

EFFECTS OF NITROGEN RATES ON FODDER YIELDS IN CAULIFLOWER PRODUCTION[1]

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Abstract: The trials with cauliflower were performed with different nitrogen rates (80, 120 and 160 kg ha^{-1}) under field conditions. Nitrogen was not applied in the control variant. The trials were carried out in soil of moderate fertility (brown forest soil). The nitrogen application increased the yield of fodder (stems and leaves) on the average by 26.20 t ha^{-1}. The optimum nitrogen rate was 120kg ha^{-1}.

Key words: cauliflower, nitrogen, fodder, yield.

Introduction

Cauliflower is an important vegetable grown for its tasty and nutritive heads (curds). After harvest of heads, stems and leaves remain in the field and are usually ploughed down and used as green manure. However, it would be much more useful if such a material is used as animal feed. Its chemical content is as follows: carbon hydrates (2.7-4.3%), proteins (0.91-1.7%), plant oils (0.08-0.15%), cellulose (0.8-1.5%), mineral matters (0.6-1.3%), etc. Cauliflower usually contains vitamin C (34mg%), vitamin B1 (0.06mg%) and carotene (0,06mg%). It is also a source of mineral matters such as potassium, calcium and sulphur (*Makarevič, 1998*).

Stem and leaves constitute 65-72% of the total plant mass and animals (livestock and poultry) willingly eat them in the fresh (newly picked), dry or silage form. If animals are fed with greater amounts of the vegetable, milk and meat can have cauliflower-(cabbage)-like odour, and bloat can occur in livestock.

Many factors, including fertilising, affect the cauliflower production. In the processes of fertilising, different biogenic elements, especially nitrogen, phosphorus and potassium, are incorporated into the soil. Nitrogen is a main creator of the yield, and its absorption by cauliflower is great (130-240 kg ha^{-1}). Furthermore, nitrogen is a constitutive element and it is an important constituent of many compounds (amino acids, proteins, chlorophyll). If nitrogen nutrition is insufficient, the development of cauliflower plants is slow, the number and size of leaves are lower, etc. On the other hand, excessive nitrogen nutrition has adverse effects - crop luxuriance increases very much, the relation between yields of curds and the vegetative mass (stem and leaves) impairs, production quality deteriorates, disease resistance weakens, etc.

Many authors have studied effects of nitrogen (fertilising) on cauliflower. *Alt et al.* (*2000*) established that fertilising with increasing rates of nitrogen (100, 150, 200 and 250 kg ha^{-1}) increased cauliflower luxuriance, but the increase of the yield was not proportional (adequate). Due to it, the average participation of stem and leaves (fodder) in the total yield amounted up to 71% (240 kg ha^{-1}). *Vasjanovič* (*1985*) points out to the nitrogen to phosphorus ratio in cauliflower nutrition and recommends the ratio of 1:0.6-0.8 in fertilising. Moreover, the amounts of 120-160 kg ha^{-1}, i.e. 80-120 kg ha^{-1} of nitrogen, i.e. phosphorus, respectively, are recommended. *Livingston et al.* (*1982*) established that nitrogen, phosphorus, i.e. potassium increased the cauliflower yield by 57.6%, 30.1%, i.e. 12.3%, respectively. These authors applied 100 and 150 kg nitrogen ha^{-1} and 80 kg each of phosphorus and potassium ha^{-1}. *Everaarts* (*2000*) indicated that approximately 100 kg nitrogen ha^{-1} was the optimum amount for cauliflower.

The objective of the present research is to contribute to studies on fertilising in the cauliflower production.

Material and methods

The two-year field trials with cauliflower (the Dutch variety Syria) were carried out on forest brown soil (eutric cambisol) in the vicinity of Belgrade (Radmilovac) in 1999 and 2000. The trial variants were as follows: $N_0P_{90}K_{80}$ (control), $N_{80}P_{90}K_{80}$, $N_{120}P_{90}K_{80}$ and $N_{160}P_{90}K_{80}$. The nitrogen fertiliser KAN (27% N) and NPK fertiliser (15:15:15) were applied.

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1 Original scientific paper

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Transplants (seedlings) were grown in open beds. Five grams of seeds were sown per m^2. Cauliflower was planted when it was 35 days old. The planting distance was 60 x 50 cm. Plants were regularly watered, hoed and protected against diseases and pests (insects).

The four-replicate trials were set up according to the randomised complete-block design. The plot size amounted to 9.6 m^2 (4 x 2.4 m). Total of 32 plants were grown in each plot.

Harvest of cauliflower curds was done in October (two harvests). Harvested plants were pulled out and divided into stems and leaves, which were used to determine the fodder yield (t ha^{-1}). Obtained results were processed by the analysis of variance.

Weather conditions

The year of 1999 had favourable conditions. First of all, there was sufficient amount of precipitation (562 mm). Only August was very dry. The temperatures were moderate and did not oscillate much.

Table 1. Mean monthly temperature and monthly sums precipitation during the period of investigation

Months	Temp. (°C)		Precipitation (mm)	
	1999.	2000.	1999.	2000.
VI	20.9	22.8	144	20
VII	22.3	23.3	265	31
VIII	23.0	25.7	12	7
IX	20.5	18.6	85	72
X	13.5	15.8	56	16
Average/Sum/prosek	20.0	21.2	562	146

The following year was characterised by warm and dry weather. The least favourable conditions for cauliflower were in August that was extremely hot and dry. Frequent and abundant irrigation of cauliflower was required.

Results and discussion

The average stem yield amounted to 11.85 t ha^{-1} (Table 2). Yields obtained in 1999 were higher, but only, by 1.14 t ha^{-1}. Nitrogen increased stem yield by 5.36 t ha^{-1}. This increase in 1999 was significantly higher (by 6.95 t ha^{-1}) than the increase in 2000 (3.76 t ha^{-1}). Greater amounts of nitrogen (120 and 160 t ha^{-1}) were more efficient, and their results were very even. Similar data were obtained by *Csizinsky* (*1996*) who applied 80-200 kg nitrogen ha^{-1} to the cauliflower crop. *Kage et al.* (*2003*) showed that each

Table 2. Stem yield

VARIANT		YIELD (t ha^{-1})		AVERAGE
		Years		
		1999.	2000.	
1. $N_0 P_{90} K_{80}$		7.21	8.46	7.83
2. $N_{80} P_{90} K_{80}$		12.02	11.23	11.62
3. $N_{120} P_{90} K_{80}$		15.37	12.59	13.98
4. $N_{160} P_{90} K_{80}$		15.08	12.85	13.96
AVERAGE	1-4	12.42	11.28	11.85
	2-4	14.16	12.22	13.19
LSD	0.05	2.04	1.51	-
	0.01	2.94	2.17	-

increase of the nitrogen amount significantly increased the cauliflower (stem) yield. Their trial encompassed three nitrogen rates: 100, 150 and 200 t ha^{-1}. According to *Mangal et al.* (*1982*) nitrogen did not affect the

cauliflower yield. The reason for such results is that they studied the cauliflower production performed on a very fertile soil.

The leaf yield was rather high and amounted to 56.40 t ha^{-1} on the average (Table 3). Moreover, the leaf yield was higher by 3.36 t ha^{-1} in 1999 than in 2000. Nitrogen also increased this yield. The average increase amounted to 20.85 t ha^{-1}. The output was significantly higher in 1999 in which the yield increase amounted even to 25.89 t ha^{-1}. On the other hand, the yield increase in 2000 was 15.81 t ha^{-1}. Leaves also strongly responded to greater nitrogen rates (120 and 160 kg ha^{-1}), and their effect was also even.

Table 3. Leaf yield

VARIANT	YIELD (t ha^{-1})		AVERAGE
	Years		
	1999.	2000.	
1. $N_0 P_{90} K_{80}$	38.67	42.86	40.76
2. $N_{80} P_{90} K_{80}$	52.28	52.61	52.44
3. $N_{120} P_{90} K_{80}$	69.61	62.14	65.87
4. $N_{160} P_{90} K_{80}$	71.78	61.26	66.52
1-4	58.08	54.72	56.40
AVERAGE 2-4	64.56	58.67	61.61
LSD 0.05	7.18	7.42	-
0.01	10.31	10.67	-

In similar traits with cauliflower, *Everaarts* (*2000*) obtained the yield increase of even 23.48 t ha^{-1}. *Alt et al.* (*2001*) achieved the yield increase of 13.06 t ha^{-1}. According to *Kage et al.* (*2003*), the highest cauliflower leaf yield (56.11 kg ha^{-1}) is obtained with the fertiliser rate of 220 kg nitrogen ha^{-1}. According to *Vasjanovič* (*1985*) such yield is achieved with 140 kg nitrogen ha^{-1}.

The total yield consists of the stem yield and the leaf yield. This yield amounted to 68.25 t ha^{-1} on the average and was higher by 4.51 t ha^{-1} in 1999 (Table 4). The response of cauliflower to nitrogen was positive and the fodder yield increase amounted to 26.20 t ha^{-1}. The effects of nitrogen were higher in 1999 in which the yield increase amounted even to 32.83 t ha^{-1}. The corresponding value in 2000 amounted to 19.57 t ha^{-1}. Cauliflower did not respond more significantly to the increase of the nitrogen rate

Table 4. Total yield of fodder

VARIANT	YIELD (t ha^{-1})		AVERAGE
	Years		
	1999.	2000.	
1. $N_0 P_{90} K_{80}$	45.88	51.32	48.60
2. $N_{80} P_{90} K_{80}$	64.30	63.84	64.07
3. $N_{120} P_{90} K_{80}$	84.98	74.73	79.85
4. $N_{160} P_{90} K_{80}$	86.86	74.11	80.48
1-4	70.51	66.00	68.25
AVERAGE 2-4	78.71	70.89	74.80
LSD 0.05	6.55	7.21	-
0.01	9.41	10.36	-

from 120 to 160 kg ha^{-1}. Our results are completely in accordance with results obtained by *Weich et al.* (*1985*). These authors applied nitrogen in the amount ranging from 80 to 200 kg ha^{-1} and obtained the yield increase of 17.34 t ha^{-1}. Increasing nitrogen rates above 120 kg ha^{-1} had no effects on cauliflower. *Livingston et al.* (*1982*) applied 100 and 150 kg nitrogen ha^{-1} and obtained the yield increase of 14.63 and 19.08 t ha^{-1}, respectively. According to *Vasjanovič* (*1985*), the highest fodder yield is obtained with the application of 220 kg nitrogen ha^{-1}.

Conclusion

The average stem, i.e. leaf yield of cauliflower amounted to 11.85, i.e. 56.40 t ha^{-1}, respectively. The positive nitrogen effect is observable in the fodder yield increase of 26.20 t ha^{-1}. The approximately even results were obtained in the trial variants with 120 and 160 kg nitrogen ha^{-1}. Cauliflower yields were higher in the more favourable year (1999 with humid and warm weather). The fodder yield in 1999 was 70,51 t ha^{-1}. It was observed that approximately 120 kg nitrogen ha^{-1} should be applied in the Belgrade region.

UTICAJ KOLIČINE AZOTA NA PRINOS KRME U PROIZVODNJI KARFIOLA

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Rezime

Karfiol je ispitivan u rejonu Beograda (Radmilovac). Ogledi su izvođeni dve godine (1999. i 2000). Tip zemljišta je gajnjača. Korišćena je sorta "siria". Varijante ogleda su: N_0 P_{90} K_{80} (kontrola), N_{80} P_{90} K_{80}, N_{120} P_{90} K_{80}, N_{160} P_{90} K_{80}. Karfiol je stizao za berbu u oktobru (kasni karfiol).

Rezultati pokazuju prinos stabala, prinos lišća i ukupni prinos krme (stabla+lišće). Karfiol je u proseku donosio 68,25 t ha^{-1} krme (11,85+56,40 t ha^{-1}). Azot je pozitivno uticao na karfiol, ali do određene granice. U stvari, taj uticaj je rastao od kontrole (N_0) do varijate sa 120 kg ha^{-1} azota i onda se zaustavio. Tako se pokazalo da u ispitivanom području (rejon Beograda) za karfiol treba koristiti oko 120 kg ha^{-1} azota.

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