EFFECT OF FERTILIZATION ON YIELD OF SUBTROPICAL HUMID RANGELANDS

I – Balakot Study

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Abstract: *Four fertilizer treatments namely control, 50 kg of nitrogen per hectare in urea, 50 kg of phosphorus per hectare in single superphosphate and 50 kg N + 50 kg P per hectare in urea and single superphosphate were applied to range vegetation in subtropical humid zone at Balakot village of Mansehra District. Nitrogen and phosphorus mixture doubled total forage and grass production and many times increased the production of desirable species, undesirable species,* Chrysopogon aucheri *and* Cymbopogon martini. *However, both nitrogen and phosphorus, when applied separately had no effect on the production of total forage, grass, any palatability class or any important forage species. No fertilizer treatment appreciably affected the forage production of intermediate species,* Themeda anathera *and* Heteropogon contortus.

Introduction: Much research on fertilization of native rangeland has been conducted in recent years in different parts of the world. Forage yields have been increased on native rangelands fertilized with nitrogen rates higher than 100 kg/ha (Lorenz and Rogler, 1972; Houston and Hyder, 1975). Burzlaff *et al.*, (1968) reported increased yield for rangeland fertilized at rates of 34 kg/ha and no increase in yield for forages fertilized at 17 kg/ha. Rauzi *et al.*, (1968), using N rates of 37 and 74 kg/ha reported no significant increase in forage yield. Samuel *et al.*, (1980), reported increase in yield with increased amounts of both fall applied and spring applied nitrogen. Nitrogen is a major growth-limiting factor in the northern Great Plain (Rogler and Lorenz, 1974; Wight, 1976). Plant response to phosphorus is much less than to N and occurs primarily as N becomes non-limiting (Lorenz and Rogler, 1972; Wight, 1976). Wight and Black (1979), reported that elimination of nitrogen and phosphorus deficiencies by fertilizing increased herbage yields an average of 114% on a mixed prairie range in eastern Montana. They further indicated that nitrogen was the major growth-limiting plant nutrient with measurable responses to P occurring only when N was non-limiting. They also pointed out that at N rates of 336 kg/ha or less, grasses increased in about the same proportion as did forbs and shrubs, maintaining a relatively constant composition of the major species groups.

Despite the demonstrated limiting effects of N and P deficiencies on plant growth, range fertilization is not a commonly accepted practice because of

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its cost. Our objective was to determine the effect of N and P applied either separately or in mixture on the yield of the native vegetation and to evaluate its economics.

Study Area and Methods: The study was conducted at Balakot village of Mansehra District in the subtropical humid zone. The mean annual rainfall in the area is about 1500 mm of which about a half falls in summer (June to September) and about a quarter in spring (February to April). November is the driest month of the year when the average rainfall is about 50 mm. January is the coldest month and June the hottest. The range of mean minimum temperature during the year is from 1° to 23°C and the mean maximum from 14° to 35°C. The average relative humidity varies from about 48 at 0800 and 33 at 1700 in June to about 81 at 0800 and 69 at 1700 in August. The area is mountainous with the mountain range running north-south. The elevation is about 500 metres, exposure western and slope about 50 percent. The parent rock is granite. The soil is well drained loam with an average depth of about 25 cm. The vegetation of the experimental area consisted of 49% *Themeda anathera*, 26% *Heteropogon contortus*, 12% *Chrysopogon aucheri*, 5% *Cymbopogon martini*, 6% other grasses and 2% forbs and shrubs by weight. Other grasses included *Bothriochloa intermedia*, *Digitaria* spp., *Aristida cyanantha* and *Rottboellia exaltata*. Forbs included *Lespedeza* spp., *Lotus* spp., *Lactuca* spp., *Plantago* spp. *Thymus* spp., and dominant shrub and tree species were *Indigofera* spp., and *Pinus roxburghii* seedlings.

The experimental design was a randomised complete block with 4 treatments and 5 replications in plots of 10m x 5m size. The treatements were control, 50 kg N per hectare, 50 kg P per hectare and a combined dose of 50 kg N and 50 kg P per hectare applied to the native rangeland during July, 1980. The blocks were laid along the contour with a 2 metre buffer zone between plots and also between blocks. The fertilizer was broadcasted evenly in the plots. The observations were recorded during October, 1980 at the time of peak production. In each 50 square metre plot, 3 subplots of one square metre each were randomly selected. The herbage in each subplot was clipped at 2 cm from the ground level. The species-wise air dry weights of the clipped material were recorded which were then added up to give total forage yield, grass production and forage production of desirable species, undesirable species and intermediate species. Analysis of variance was carried out to show whether the treamtnet means differed significantly from each other.

Results and Discussion: *Effect on forage Yield:* The effect of fertilization on total forage production is reproduced in Table 1. The analysis of variance showed that fertilization enhances the total forage production highly significantly (P .005). The three fertilizers also differed highly significantly in their effect on total forage production. Both nitrogen and phosphorus when applied separately did not increase the total forage production significantly but the combined dose of nitrogen and phosphorus had a synergistic effect and increased

the total forage production 117 percent (P .005). This suggests that both nitrogen and phosphorus are limiting nutrients and addition of only one of these does not obliviate the situation. However, when both are added together, the increase is more than double the sum of additional forage production due to addition of nitrogen and phosphorus fertilizers separately. The results of this study are comparable to those reported by Wight and Black (1979), who found that nitrogen and phosphorus combined increased herbage yield an average of 114%. They further reported that measurable responses to phosphorus occurred only when N was non-limiting.

Effect on Grass Production. The grass production with different fertilizer treatments is shown in Fig. 1. The responses of grass yield to N, P and mixture of N and P had exactly the same trends as reported for forage production.

Effect on Forage Production of Various Palatability Grasses: Table 2 shows the forage production of various palatability classes with different fertilizer treatments. The fertilization increased the forage production of desirable and undesirable species significantly (P .05) but had no appreciable effect on the intermediate species production (P .10). The three fertilizers differed highly significantly (P .005) in their effect on the forage production of desirable and undesirable species. Nitrogen and phosphorus applied separately did not have a measurable effect on the production of all three palatability classes but combined application of N and P enhanced the forage production of desirable and undesirable species 4.2 and 5.6 times respectively (P .005). The contribution of desirable, undesirable and intermediate species changed from 15, 9 and 76 per cent respectively in the unfertilized vegetation to 30, 23 and 47 per cent respectively in the vegetation fertilized with N and P mixture. If palatability of desirable, intermediate and undesirable species is scored as 1, 2 and 3, the fertilization with N and P did not change the palatability of vegetation. However because of the change in palatability of forage within each class (not measured) the resultant increase in palatability due to fertilization might have been significant.

Effect on Important species: Fertilization highly significantly (P .005) increased the production of *Chrysopogon aucheri* and *Cymbopogon martini* but had no measurable effect on the production of *Heteropogon contortus* and *Themeda anethera.* For the former two grass species the nitrogen and phosphorus fertilization did not affect their yield. However nitrogen and phosphorus mixture increased the yield of *Chrysopogon aucheri* and *Cymbopogon martini* 4.7 and 6.8 times respectively over control. *Themeda anethera* and *Heteropogon contortus* are intermediate species while *Chrysopogon aucheri* is desirable and *Cymbopogon martini* undesirable species.As these are the four major species in the project area, the response of desirable, undesirable and intermediate species is a result of response of these four major species. The fertilization, therefore, highly significantly increased the production of desirable and undesirable species but had no effect on the production if intermediate species.

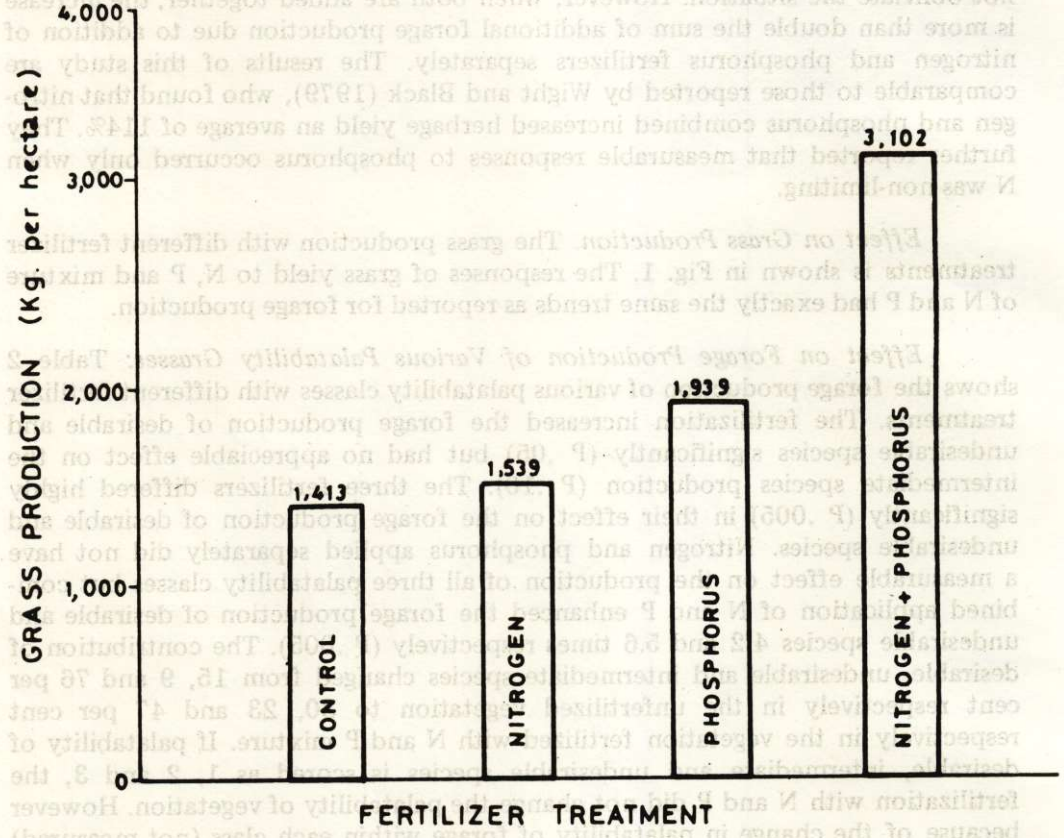

Fig. 1- Effect of fertilizer on grass production at Balakot

Economic Analysis: The cost of application of mixed nitrogenphosphorus fertilizer to one hectare of subtropical humid rangelands is worked out as under:

Quantity of urea required for 50 kg N	=	$\frac{50}{.46}$ = 0109 Kg.
Market price of 109 kg urea at the rate of Rs. 75/- per Kg	=	$109 \times \frac{75}{50}$ = Rs. 164.00
Quantity of single super phosphate required for 50 Kg P	=	$\frac{50}{.18}$ = 278 Kg.
Market price of 279 Kg single superphosphate at the rate of Rs. 22/- per 50 Kg	=	$278 \times \frac{22}{50}$ = Rs. 122.00
Total price of the fertilizer	=	164+122 = Rs. 286.00
Transportation charges to the site	=	Rs. 100.00
Charges for application of fertilizer	=	Rs. 30.00
	Total:	= Rs. 416.00
Additional forage yield due to application of N + P fertilizer	=	3133 - 1443 = 1690 Kg.
Price of 1690 Kg forage at local market rate at Rs. 1/- per kg	=	Rs. 1690.00
Therefore cost of application of N + P fertilizer	=	Rs. 416.00
Benefits of application of N + P fertilizer	=	Rs. 1690.00
Net benefits per hectare	=	Rs. 1274.00
Benefit/cost ratio	$\frac{1690}{416}$ =	4.0

Conclusions. Nitrogen and phosphorus, when applied separately, do not increase the forage yield appreciably but when a mixture of N and P is applied, due to interaction, it doubles the forage yield and grass yield, enhances the production of desirable and undesirable species 4.2 and 5.6 times respectively and

that of *Chrysopogon aucheri* and *Cymbopogon martini* 4.7 and 7.0 times respectively. However fertilization does not affect the production of intermediate species, *Themeda anethera* and *Heteropogon contortus*.

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Table 1

Effect of fertilizer on forage production at Balakot.

Fertilizer	Block					Average
	1	2	3	4	5	
Control	1393	1643	1390	1617	1173	1443
Nitrogen	1553	1917	1530	1283	1880	1632
Phosphorus	1330	2217	2746	2273	1307	1975
Nitrogen+ Phosphorus	3398	3393	2853	2810	3210	3133**

1. 50 kg. per hectare.
2. 50 kg. per hectare.
3. 50+50 kg. per hectare.
4. Average of three random observations.

**denotes highly significantly different at 0.01 level.

Table 2

Forage production of various palatability classes by application of fertilizer at Balakot.

Kg. per hectare

Fertilizer	Forage Class			Total
	Desirable	Undesirable	Intermediate	
Control	223	126	1094	1443
Nitrogen	339	268	1025	1632
Phosphorus	240	299	1436	1975
Nitrogen + Phosphours	927**	711**	1495	3133**

1. 50 kg. per hectare.
2. 50 kg. per hectare.
3. 50+50 kg. per hectare.
4. Average of three random observation.

** denotes highly significantly different at 0.01 level.

Table 3

Effect of fertilizer on production of Chrysopogon aucheri at Balakot.

Kg. per hectare

Fertilizer	Block					Average
	1	2	3	4	5	
Control	367	283	100	37	107	179
Nitrogen	400	167	147	440	333	297
Phosphorus	110	216	327	90	250	199
Nitrogen + Phosphorus	1133	1517	916	117	533	843**

1. 50 kg. per hectare.
2. 50 kg. per hectare.
3. 50+50 kg. per hectare.
4. Average of three random observations.

** denotes highly significantly different at 0.01 level.

Table 4

Effecto of fertilizer on production of Cymbopogon martini at Balakot.

Kg. per hectare

Fertilizer	Block					Average
	1	2	3	4	5	
Control	50	33	70	133	57	67
Nitrogen	133	300	67	27	213	148
Phosphorus	267	350	200	133	13	192
Nitrogen + Phosphorus	433	516	450	934	—	467**

1. 50 kg. per hectare.
2. 50 kg. per hectare.
3. 50+50 kg. per hectare.
4. Average of three random observations.

**denotes highly significantly different at 0.01 level.