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Effect of Nitrogen and Phosphorus Levels on the Yield Parameters of Sugarcane Varieties

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Abstract: An experiment was conducted at Malakandher Research Farm of NWFP Agricultural University Peshawar, during 2001-2002 in RCB split plot arrangement replicated four times. Sugarcane varieties planted were Mardan-93 and CP.77/400. Four different NP fertilizer levels i.e. control (0:0), 100:50, 150:75 and 200:100 kg ha^{-1} were applied. Setts @ 10000 kg ha^{-1} were used. Maximum cane stalk height (218.93 cm), maximum cane stalks weight m^{-2} (9.16 kg) and maximum cane yield (91.62 t ha^{-1}) were obtained from Mardan-93 variety at 100:50 NP level kg ha^{-1}. Maximum number of stalk m^{-2} at harvest (11.08), Maximum number of millable canes m^{-2} (11.11) and maximum cane top ratio (2.77) were recorded with 100:50 NP level kg ha^{-1}. Maximum number of shoots m^{-2} in April (22.09) was recorded with 200:100 Kg NP ha^{-1}. Maximum number of shoots m^{-1} in May (27.306) was obtained from Mardan-93 variety. Maximum cane stalk thickness (2.36 cm) was obtained from CP 77/400 variety and maximum cane top weight m^{-2} (3.61 kg) was obtained from Mardan-93. Mardan-93 variety gave highest yield of 100.50 t ha^{-1} with NP fertilizer at the rate of 100:50 kg ha^{-1} was proved best.

Key words: NP, varieties, sugarcane

Introduction

Sugarcane is cash crop use as the raw material for the sugar industry. In Pakistan, it provides income to the grower and employment for numerous farm workers through out the year. About 30% of the cane is crushed in sugar mills, 60% is used for making unrefined sugar and about 10 % is retained as seed. A small quantity is also produced for chewing. Cane juice is used in the manufacture of gur, shakar and sugar and cane tops as fodder. The by-products of the sugar industry are bagasse, molasses, filter-cake and wax. Bagasse is used in the manufacture of paper, hardboard and livestock feed as well as fuel for boilers. Molasses can be used in the manufacture of alcohol, livestock feed and fertilizers. Filter-cake is a rich source of organic matter and macro and micronutrients. Sugarcane wax obtained for filter-cake is used in the manufacture of shoe polish. Sugarcane is an exhaustive crop that takes large quantities of various nutrients from the soil. Due to continuous cultivation, the soil nutrients and the crop yield declines unless plenty of plant food nutrients are applied. In Peshawar valley of NWFP mostly the cane growers only use Nitrogen and Phosphorus. Because of excess of Potassium in the Peshawar valley soil, the cane growers do not mostly use it. Moreover, the fertilizer rates are becoming very high day by day due to shortage. So, awareness of proper NP fertilizer ratio for sugarcane is of utmost importance. Along with this extensive application of nutrients including nitrogen and phosphorus, which has a deleterious effects on the crop and the law of diminishing return starts operating to meet the shortage and high price of these fertilizers as nutrients, careful application is must to minimize the losses of these nutrients. This is only possible if an optimum dose is searched out through experimentation. Besides the use of adequate and balanced fertilizer, awareness of suitable and improved sugarcane varieties to farmers is also necessary for getting high cane yield and high sugar recovery. Bahadur *et al.* (1980) concluded that 135 kg N ha^{-1} is the economical dose for obtaining higher sugar recovery and cane yields. Increasing N rate upto 225 kg ha^{-1} significantly increased the CCS yield, while higher levels gave a decrease. Increasing N rate decreased sucrose content of cane juice (Rawat *et al.*, 1989). Kannappan and Manickasundaram (1990) stated that high level of Nitrogen fertilizer gave the highest net return from cane yield. Verma-HD (1999) reported that plots were treated at the rate 0, 150, 225 or 300 kg N ha^{-1} and stated that cane yield was highest with 300 kg nitrogen.

The present study "Effect of Nitrogen and Phosphorus levels on the yield parameters of sugarcane varieties" would help in making recommendation of a cultivar and its response to different levels of NP fertilizers for maximum production of sugarcane.

Materials and Methods

The experiment on the effect of Nitrogen and Phosphorus levels on the yield parameters of sugarcane varieties, was conducted at Malakandher Research Farm, NWFP Agricultural University Peshawar during 2001-02, in RCB

Split plot arrangement replicated four times in a subplot size of 3 x 12m and planted Setts at the rate of 10000 Kg ha^{-1} with double overlapping setts method with row-to-row spacing of 0.75m. The field was irrigated as per crop water requirements at regular intervals. Cultural practices were timely carried out for all treatments. Four different NP fertilizer levels i.e. control (0:0), 100:50, 150:75 and 200:100 kg ha^{-1} were applied to the respective plots according to sowing plan. Control plot having no fertilizer, was kept as check treatment to compare the performance of various fertilizer doses and their influence on growth and cane yield.

The following observations were studied:

1. Shoots in April m^{-2}
2. Shoots in May m^{-2}
3. Number of stalks m^{-2} at harvest
4. Stalk height (cm)
5. Stalk thickness (cm)
6. Millable canes m^{-2}
7. Top weight m^{-2}
8. Stalk weight m^{-2}
9. Cane top ratio
10. Cane yield t ha^{-1}.

The above mentioned parameters were recorded in the following manner:

Data on number of shoots or stalks and water shoots per meter length of row were recorded with the help of a meter rod. The meter rod was thrown randomly three times in each treatment and the number of shoots or stalks was counted and their means were calculated and then the data was converted into meter square by the following formula:

$$\frac{\text{No. of shoots } m^{-1} \text{ length of row x 1m x 1m}}{\text{Row length (i.e.1m) x width (.75m)}}$$

Cane height was measured with the help of a measuring tap. Three randomly selected stalks of varying sizes were measured in centimeters in each treatment and mean height was recorded as the distance from the ground level to the top leaf. Stalk diameter or thickness of the said canes at base, middle and top was gauged with the help of a Caliper in centimeters. Stripped canes of almost more than 10 buds $cane^{-1}$ with an average length of 1 – 1.5m were considered as millable cane and of less length were considered as non millable cane. At harvest three random spots were tagged and millable and non-millable canes were determined. Top weight was recorded at harvest, tops and canes were separated and were recorded by weighing tops and cane separately with the help of a spring balance and then mean top weight was calculated in kg m^{-2}. Cane stalk weight was recorded by harvesting each treatment separately. The plants were stripped, topped and weighed in kilogram with the help of a spring balance. After finding or recording the top weight and cane stalk weight, cane-top ratio was found by the following formula:

$$\text{Cane top ratio} = \frac{\text{Stalk weight (kg)}}{\text{Top weight (kg)}}$$

Cane yield was recorded by harvesting each treatment separately. The plants were stripped, topped and weighed in kilogram with the help of a spring balance. Then that recorded data was converted into tones by dividing wt. in kg by 1000. Then this was converted into t ha^{-1} by the following formula:

$$\text{Yield t ha}^{-1} = \frac{\text{Yield (t)}}{\text{Subplot area*}} \times 10000$$

* = Here subplot area is on square meter bases (i.e. $1m^2$)

The data collected during the experiment was analyzed according to RCB design and upon obtaining significant differences Least Significant Differences (LSD) test was applied Steel and Torrie (1980).

Results and Discussion

Shoots m^{-2} in April: Statistical analysis of the data presented in Table 1 showed that various NP levels kg ha^{-1} had significantly ($P \leq 0.05$) affected number of shoots $meter^{-2}$ of sugarcane varieties in April. Highest number of 22.09 shoots m^{-2} was recorded with the application of 200:100 Kg NP ha^{-1}, followed by 150:75 kg NP ha^{-1} with 20.77 number of shoots m^{-2}. Control and 100:50 kg NP ha^{-1} were at par statistically. Sugarcane varieties Mardan-93 and CP.77/400 had no significant difference between them. As regards interaction of NP levels x varieties of sugarcane, significant differences had been recorded. In case of interaction between varieties and NP levels, highest number of 22.65 shoots m^{-2} was recorded by plots treated at the rate of 200:100 kg NP ha^{-1} x Mardan-93 variety of sugarcane, followed by 150:75 NP of the same variety. Lowest number of shoots m^{-2} was recorded by 0:0 NP Kg ha^{-1} in Mardan-93 variety of sugarcane.

Shoots m^{-2} in May: The data presented in Table 2 indicated that various NP levels kg ha^{-1} had not significantly affected the number of shoots $meter^{-2}$ of

Table 1: Number of shoots m^{-2} in April as affected by different NP levels in sugarcane varieties

	Varieties		
NP levels (kg ha^{-1})	Mardan-93	Cp-77/400	Mean
0:0	19.37f	20.95cd	20.16c
100:50	20.45de	19.92ef	20.19c
150:75	21.70b	19.85ef	20.77b
200:100	22.65a	21.52bc	22.09a
Mean	21.04	20.56	

LSD value at 5% for NP levels = 0.4591
LSD value at 5% for interaction = 0.6492

Table 2: Number of shoots m^{-2} in May as affected by different NP levels in sugarcane varieties

	Varieties		
NP levels (kg ha^{-1})	Mardan-93	Cp-77/400	Mean
0:0	24.47bc	25.80c	21.138
100:50	26.87b	25.85c	26.362
150:75	27.72a	24.47d	26.100
200:100	28.15a	24.97d	26.563
Mean	27.31a	21.28b	

LSD value at 5% for interaction = 0.7662

Table 3: Number of stalks m^{-2} at harvest as affected by different NP levels in sugarcane varieties

	Varieties		
NP levels (kg ha^{-1})	Mardan-93	Cp-77/400	Mean
0:0	9.22	8.77	9.00c
100:50	11.65	10.52	11.08a
150:75	10.07	10.15	10.11b
200:100	10.35	9.85	10.10b
Mean	10.32	9.82	

LSD value at 5% for NP levels = 0.6577

Table 4: Cane stalk height (cm) as affected by different NP levels in sugarcane varieties

	Varieties		
NP levels (kg ha^{-1})	Mardan-93	Cp-77/400	Mean
0:0	213.00cd	205.00e	209.00c
100:50	226.25a	211.25d	218.75a
150:75	220.25b	214.00cd	217.12ab
200:100	216.25c	213.25cd	214.75b
Mean	218.93a	210.87b	

LSD value at 5% for NP levels = 2.744
LSD value at 5% for interaction = 3.880

Table 5: Cane stalk thickness (cm) as affected by different NP levels in sugarcane varieties

	Varieties		
NP levels (kg ha^{-1})	Mardan-93	Cp-77/400	Mean
0:0	2.23	2.33	2.28
100:50	2.30	2.35	2.33
150:75	2.24	2.39	2.31
200:100	2.20	2.38	2.29
Mean	2.24 b	2.36 a	

Table 6: Millable canes m^{-2} as affected by different NP levels in sugarcane varieties

	Varieties		
NP levels (kg ha^{-1})	Mardan-93	Cp-77/400	Mean
0:0	9.23	9.02	9.12b
100:50	11.70	10.52	11.11a
150:75	9.82	10.02	9.92ab
200:100	10.00	9.85	9.92ab
Mean	10.19	9.86	

LSD value at 5% for NP levels = 1.254

Table 7: Cane top weight m^{-2} (kg) as affected by different NP levels in sugarcane varieties

	Varieties		
NP levels (kg ha^{-1})	Mardan-93	Cp-77/400	Mean
0:0	3.65	3.45	3.55
100:50	3.92	3.00	3.46
150:75	3.52	3.00	3.26
200:100	3.35	3.27	3.31
Mean	3.61a	3.18b	

Table 8: Cane stalk weight m^{-2} (kg) as affected by different NP levels in sugarcane varieties

	Varieties		
NP levels (kg ha^{-1})	Mardan-93	Cp-77/400	Mean
0:0	8.45de	8.02e	8.23c
100:50	10.05a	9.05bc	9.55a
150:75	9.45b	8.32de	8.88b
200:100	8.70cd	8.95c	8.82b
Mean	9.16a	8.58b	

LSD value at 5% for NP levels = 0.3134
LSD value at 5% for interaction = 0.4432

Table 9: Cane top ratio as affected by different NP levels in sugarcane varieties

	Varieties		
NP levels (kg ha^{-1})	Mardan-93	Cp-77/400	Mean
0:0	2.30	2.32	2.31b
100:50	2.55	3.00	2.77a
150:75	2.70	2.77	2.73a
200:100	2.57	2.77	2.67a
Mean	2.53	2.72	

LSD value at 5% for NP levels = 0.2325

Table 10: Cane yield (t ha^{-1}) as affected by different NP levels in sugarcane varieties

	Varieties		
NP levels (kg ha^{-1})	Mardan-93	Cp-77/400	Mean
0:0	84.50de	80.25e	82.37c
100:50	100.50a	90.50bc	95.50a
150:75	94.50b	83.25de	88.87b
200:100	87.00cd	89.50c	88.25b
Mean	91.62a	85.87b	

LSD value at 5% for NP levels = 3.142
LSD value at 5% for interaction = 4.443
Mean values of the same category followed by different letters are significant at $P \leq 0.05$ level.

sugarcane varieties in May. Highest number of 27.31 shoots m^{-2} was recorded in Mardan-93 and lowest number of 25.28 shoots m^{-2} was observed in CP.77/400. Interaction between NP levels and varieties of sugarcane, significant differences were recorded. Mean value of the data indicated that highest number of 28.15 shoots m^{-2} was recorded by plots fertilized at the rate of 200:100 kg NP ha^{-1} and sown with variety Mardan-93, followed by

150:75 kg NP ha^{-1} of the same variety. Lowest number of shoots m^{-2} was recorded by 150:75 and 200:100 kg NP ha^{-1} in CP.77/400 variety of sugarcane in May. This observation is supported by Gaholt (1956) who stated that application of nitrogen increased tillers $plant^{-1}$.

Number of stalks m^{-2} at harvest: Analysis of the data showed in Table 3 revealed that various NP levels had significantly ($P \leq 0.05$) affected number of stalks $meter^{-2}$ of sugarcane varieties at harvest. It can be inferred from the data presented in Table 3 that highest number of 11.08 stalks m^{-2} were recorded from those plots treated at the rate of 100:50 Kg NP ha^{-1}, followed by 150:75 Kg NP ha^{-1} and 200:100 Kg NP ha^{-1} with 10.11 stalks m^{-2} and 10.10 stalks m^{-2} respectively and were statistically at par. Lowest number of 9.00 stalks m^{-2} was recorded with control (0:0) Kg NP ha^{-1}. Mean value of the data indicated that sugarcane varieties namely Mardan-93 and CP.77/400 had no significant differences between them. As regards interaction between NP levels and varieties of sugarcane, no significant differences were recorded. This result is in line with Gaholt(1956),who pointed out that application of nitrogen-increased tillers $plant^{-1}$.

Stalk height (cm): The data presented in Table 4 revealed that various NP levels had significantly ($P \leq 0.05$) affected cane stalk height of sugarcane varieties. Mean value of the data indicated that tallest plants of 218.75 cm was recorded with the application of 100:50 kg NP ha^{-1}, followed by 150:75 kg NP ha^{-1} with 217.12 (cm) stalk height, followed by 200:100 kg NP ha^{-1} with 214.75 (cm) stalk height. Control plots gave the lowest value of 209.0 (cm) stalk height statistically. In case of sugarcane varieties Mardan-93 and CP.77/400 had significant differences between them. Variety mardan-93 with 218.93 (cm) height gave the tallest stalk. And the lowest of 210.87 (cm) stalk height was given by CP.77/400 sugarcane variety. Interaction of NP levels x varieties of sugarcane, significant differences have been recorded. Highest of 226.25 (cm) stalk height was recorded by plots treated at the rate of 100:50 kg NP ha^{-1} and sown with variety Mardan-93, followed by 150:75 kg NP ha^{-1} of the same variety. The possible reasons for these results could be the genetic makeup and combination of different genes that were activated favorably at Peshawar Valley condition and produced taller plants than the other variety. Lowest value of stalk height (cm) was recorded by control plots (0:0) with 205.00 (cm) stalk height in CP.77/400 variety of sugarcane.

Stalk thickness (cm): Data presented in Table 5 showed that various NP levels had not significantly affected cane stalk thickness (cm) of sugarcane varieties. Mean value of the data indicated that sugarcane varieties Mardan-93 and CP.77/400 had significant differences between them. Variety CP.77/400 gave thickest stalk of 2.36 cm, followed by Mardan-93 with 2.24 (cm) stalk thickness. In case of interaction between NP levels and varieties of sugarcane, no significant differences were recorded. Narwal and Malik (1981) stated that there were varieties differences in respect of stalk thickness under the effects of N the differences in yield between three varieties tested were non-significant.

Millable canes m^{-2}: Statistical analysis of the data presented in Table 6 revealed that various NP levels had significantly ($P \leq 0.05$) affected millable canes m^{-2} of sugarcane varieties. It can be inferred from the data presented in Table 6 that highest number of 11.11 millable canes m^{-2} was recorded from those plots which received NP at the rate of 100:50 kg ha^{-1}, followed by 150:75 and 200:100 kg NP ha^{-1} with 9.92 and 9.92 millable canes m^{-2} respectively. 150:75 and 200:100 NP levels kg ha^{-1} were at par statistically. Lowest millable canes of 9.12 m^{-2} were recorded with control treatment. Sugarcane varieties, Mardan-93 and CP.77/400 had no significant differences between them. As regards interaction of NP levels x varieties of sugarcane, no significant differences had recorded. Salunkhe *et al.* (1981) reported that millable Canes were achieved by increasing the dosage rate from 168-337 kg ha^{-1}.

Cane top weight m^{-2}: The data indicated in Table 7 revealed that various NP levels had not significantly affected cane top weight m^{-2} (kg) of sugarcane varieties. Varieties namely Mardan-93 and CP.77/400 had significant differences in cane top weight m^{-2} (kg). Mardan-93 gave highest of 3.61 kg cane top weight m^{-2}, followed by CP.77/400 with 3.18 kg cane top weight m^{-2}. Interactions between NP levels and varieties of sugarcane, no significant differences were recorded. The possible reason could be the different genetic potential of these varieties. And other reason could be that genes responsible for increase cane top weight, might be favored by Peshawar valley conditions.

Cane stalk weight m^{-2}: Analysis of the data presented in Table 8 showed that various NP levels had significantly affected cane stalk weight m^{-2}(kg) of sugarcane varieties. Mean value of the data indicated that highest of 9.55 kg cane stalk weight m^{-2} was recorded with the plots treated with the rate of 100:50 kg NP ha^{-1}, followed by 150:75 and 200:100 kg NP ha^{-1} with the 8.88 and 8.82 kg cane stalk weight m^{-2} at par statistically. The lowest cane stalk

weight m^{-2} was recorded with control treatment. Sugarcane varieties Mardan-93 and CP.77/400 had significantly affected stalk weight m^{-2} (kg). Variety Mardan-93 gave highest stalk weight m^{-2} of 9.16 (kg), followed by CP.77/400 with 8.58 (kg) stalk weight m^{-2}. In case of interaction between NP levels and varieties of sugarcane, significant differences were recorded. Highest stalk weight m^{-2} of 10.05 kg was recorded by 100:50 NP and sown with Mardan-93 variety of sugarcane. Lowest stalk weight m^{-2} was recorded by 0:0 Kg NP ha^{-1} with CP.77/400. This observation is supported by Gascho and Kidder (1979) who sated those high rates of P and K might have caused nutritional imbalances by affecting the uptake of N, ca and Mg etc. The observation is also supported by Hussain (1965) who recorded the maximum yield of millable cane at Multan with 90:67 Kg NP ha^{-1}.

Cane top ratio: Data in Table 9 showed that various NP levels had significantly ($P \leq 0.05$) affected cane top ratio of sugarcane varieties. In case of fertilizer treatments highest cane top ratio of 2.77, 2.73 and 2.67 were recorded with the application of 100:50, 150:75 and 200:100 kg NP ha^{-1} respectively and were at par statistically, followed by the lowest cane top ratio of 2.31 with control (i.e. 0:0 kg NP ha^{-1}). Interaction between NP levels and varieties of sugarcane could not record significant differences. Mean value of the data indicated that plots treated at the rate of 100: 50 kg NP ha^{-1} and seeded with CP. 77/400 gave better results.

Cane yield (t ha^{-1}): The data presented in Table 10 revealed that various NP levels had significantly ($P \leq 0.05$) affected yield (t ha^{-1}) of sugarcane varieties. Mean value of the data presented in Table 10 indicated that highest yield 95.50 (t ha^{-1}) was recorded with the plots treated at the rate of 100:50 kg NP ha^{-1}, followed by 150:75 and 200:100 kg NP ha^{-1} which were at par statistically with 88.87 and 88.25 kg respectively. Control plots (0:0) with 82.37 yield (t ha^{-1}) was recorded as lowest yield. Sugarcane varieties, namely Mardan-93 and CP.77/400 had also significantly affected yield (t ha^{-1}) of sugarcane varieties. Variety mardan-93 gave highest yield of 91.62 t ha^{-1}, followed by CP.77/400 with 85.87 t ha^{-1} yield of sugarcane. As regards interaction of levels x varieties of sugarcane, significant differences were recorded. It can be inferred from the data that highest yield of 100.50 t ha^{-1} was recorded with 100:50 NP and sown with Mardan-93 variety of sugarcane, followed by 150:75 NP with 94.50 t ha^{-1} yield of the same variety. Lowest yield of 80.25 t ha^{-1}) with control (0:0) in CP.77/400 variety of sugarcane was recorded. Irfanuddin and Singh (1981) found that with an increase in the nutrients, the cane and sugar yields were increased but the sucrose content was reduced.

In the light of the above investigation it is concluded that balance 100:50 NP kg ha^{-1} fertilizer should be applied to sugarcane variety Mardan-93 for maximum quantitative yield.

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