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Response of Mustard (Brassica. Sp) to Fertilization Variants and Soil-Plant Nitrogen Accumulations

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Abstract: A field study was carried out to determine the soil and plant N status affected by soil application of different fertility levels in mustard (Brassica. Sp). The treatments included i.e. 0-0-0, 60-0-0, 60-20-0, 60-20-10, 60-30-0, 60-30-10, 60-30-20 kg NPK / acre $^{-1}$ and 60-30-20+4 kg NPK+ Zn acre^{-1}. The results revealed that the soil N was highest at 0-15 cm depth (0.08%) under highest NPK rate (60-30-20 kg) with 4 kg Zn acre $^{-1}$ and at 15-30 cm depth (0.041%) under NPK rates of 60-30- 20 kg ha^{-1}. In all the cases, the values were lowest under control, where soil N application was zero. The plant N analysis indicates that straw N content was significantly higher (2.67%) in plants receiving NPK levels as 60-30-10 kg ha^{-1}, followed by straw N content of 2.64, 2.66, 2.51, 2.48 and 2.43%, recorded in mustard plants fertilized with 60-30-20, 60-30-20-4 (Zn), 60-30-0, 60-0-0, 60-20-10 and 60-20-0 kg NPK ha'1, respectively. However, the lowest straw N content of 1.217 % was noted in control plants, where no fertilizer was applied. Grain N content was significantly higher i.e. 2.33, 2.29, 2.28, 2.27 and 2.27 % when plants received NPK at the rate of 60-30-0, 60-30-50-4 (Zn), 60-0-0, 60-30-10 and 60-30-20 kg ha^{-1}, respectively. The grain N content was slightly lower 2.23% and 2.17% when mustard plants were fertilized with NPK at the rates of 60-20-10 and 60-20-0 kg ha^{-1}, respectively. However, the minimum grain N content of 1.27% was noted in plants receiving no fertilizers.

Keywords: Soil Fertility level, nitrogen status, Soil N, Plant N, Mustard

1. INTRODUCTION

The mustards (Brassica. Sp) are important crop grown for its oil content for both food and fuel purposes. The seeds are used as a spice and by grinding oil used for daily purpose. Mustard (Brassica juncea), have relatively low erucic acid and low glucosinolates (Ahmad, *et al.*, 1998; Anonymous, 2014).It is widely grown in North Africa, the Middle East, Mediterranean Europe India, UK, Canada, US, Argentina, Chile, the US and some European countries. Canada grows 90% of all the mustard seeds for the international market (Wikipedia, 2007). Fertilizer occupies a pivotal position in boosting growth & nourishment of crop production. Nitrogen (N), phosphorus (P) and potassium (K) requirements of canola and mustard are similar to those of small grains. In Pakistan fertilizer consumption increased substantially since its introduction in early sixties. However, in spite of increased input over the years, per hectare yield of crops remained low compared to other countries (PES, 2011; Ahmed *et al.*, 1999). Among other factors, the nutrients needed by crop plants are deemed to be the key factor. Nitrogen (N), phosphorous (P) and potassium (K) play a vital role in plant growth and development. The imbalance use of fertilizers, ie. N, P and K is one of the major factors for low fertilizer use efficiency, which has an adverse impact on crop production (Rasheed and Memon, 2001; NFDC, 2011-12). Zinc is one of the essential micronutrients required by plants in smaller quantity. Zinc functions are mainly as a metal activator for several enzymes including carbonic anhydrate, alcohol dehydrogenase, superoxidase dimutase, and RNA polymerase (Barlog and Grzebisz, 2004). Nitrogen being the essential nutrient element for plant growth and productivity is applied in a variety of forms and combinations. In a study, (Laaniste *et al.*, 2004) evaluated seven fertilization variants including N applied at different growth stages of rape and mustard at regrowth 80, stem elongation 80 and 50 flower buds at all visible stages. While in another study (Laaniste *et al.*, 2004) using same fertilizer treatments studying the system of fertilization found that N applied in the two-split system gave the highest NUR (387 mg m^2 day^{-1}). Moreover, (Vasilyuk and Shapsheeva, 2014) applied 120 kg N ha^{-1} and revealed that different N levels influenced the oil content and dry matter in mustard. Considering the significance of NPK fertilizers in relation to their impact on growth, seed yield and oil content in mustard, the studies were carried out with objectives a) to ascertain the effect of N, P & K fertilizer rates on agronomic parameters and soil-plant N accumulation b) development of protein & oil extent

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of mustard under agro-ecological conditions of Tandojam, Hyderabad, Sindh.

2. MATERIALS AND METHODS

1.1Experimental Site, agronomic & fertilizer practices

The research experiment was laid out at field area of Wheat Research Institute Sakrand Nawabshah (26.1520° N, 68.2683° E) research area, designed in randomized complete block design (RCBD), with three replicates. The sub-plot size was 3 m x 10.0 m = 30 m^2. The seed of mustard variety **PS-78** was drilled at a distance of 45 cm from row to row and 3 cm from plant to plant. Nitrogen was given in shape of Urea (46 % N) in three equal splits. One third N with P as DAP (P_2O_5 = 46%) and K as SOP (K_2O = 50%) and Zn as Zinc sulphate (Zn=**33**%) of Engro chemical Pvt. LTD were applied at the time of sowing and one third N at the time of first irrigation and remaining N was applied at the time of flowering. Required cultural & agronomic practices were exercised in all plots according to crop needs throughout the period of growth.

2.2 Soil sampling and analysis;From each replication, composite soil samples were obtained from two depths 0-15 and 15-30 cm before fertilizer application. The samples were air dried, sieved through mm sieve and analyzed for the following physico-chemical properties. Soil samples were also taken from each replication after completion of the research trail. All soil samples were analyzed for various physico-chemical determinations such as Soil Texture (Sand, Silt, Clay), pH, EC, organic matter, nitrogen, phosphorus, potassium, zinc and $CaCO_3$ contents.

Table 1. Methods adopted for Soil properties and Plant N analysis

Determinations	Methods adopted
Texture	Bouyoucous Hydrometer method Practical Agri. Chemistry Kanwar and Chopra (1959) p. 48.
Electrical conductivity EC (dSm-1)	1:5 soil water extract by using conductivity digital meter model HI-8333).
Soil reaction (pH)	1:5 soil water extract by using Suntex pH meter (Model SP-34)
Organic matter	By Walkley-Black method "Soil and Chemical Analysis" By M.L.Jackson (1959).
Lime content	By acid neutralization method. Practical Agri. Chemistry
Total Nitrogen	By modified Kjeldahl method as described in soil chemical analysis by M.L. Jackson, (1958) method No. 8-4, p.183.
Available Phosphorus	By AB-DTPA method using Spectrophotometer
Exchangeable Potassium	By AB-DTPA method, using Flame photometer

3.3 Data analysis & interpretation. The data thus collected were subjected to statistical analysis, using analysis of variance to ascertain the significance level of the differences between treatments; the L.S.D. (Least Significant Differences) test was employed to examine the significance within treatments. The statistical analyses were performed through computer using M Stat-C following the methods suggested by (Gomez and Gomez, 1984).

3. RESULTS AND DISCUSSION

Physico-chemical properties of soil before mustard sowing

The soil analysis indicated that the experimental soil comprised of 14.5% sand, 45.5% silt and 40.0% clay at 0-15 cm depth, while at 15-30 cm depth the soil had 16.2% sand, 42.3% silt, 41.5% clay and considered as silty clay loam in texture (**Table-2**).

Table 2. Physicochemical properties of the experimental soil

Determinations	Properties	
	0-15 cm	15-30 cm
EC dS m^{-1}	0.36	0.34
Soil reaction (pH)	7.67	7.86
Organic matter %	0.74	0.58
$CaCO_3$ %	15.33	16.42
Total Nitrogen %	0.04	0.03
Available Phosphorus (mg/kg)	3.12	1.86
Exchangeable Potassium (mg/kg)	158	149

The soil determination further indicated that the composite soil samples from the experimental soil had pH level of 7.63, EC 0.37 dSm^{-1}, organic matter 0.84 %, $CaCO_3$ 16.42%, N 0.05 %, AB-DTPA extractable phosphorus 2.67 mg kg^{-1} and AB-DTPA extractable potassium 160.91 mg kg^{-1} at 0-15 cm soil depth, while at 15-30 cm soil depth, experimental soil had pH level of 7.97, EC 0.33 dSm^{-1}, organic matter 0.63 %, $CaCO_3$ 16.30%, (Nitrogen 0.04 % total), AB-DTPA extractable phosphorus 1.65 mg kg^{-1} and AB-DTPA extractable potassium 155.25 mg kg^{-1}. The experimental soil was with higher pH at 15-30 cm soil, but relatively lower in EC, organic matter, $CaCO_3$, N and experimental soil had pH level of 7.63, EC 0.37 dSm^{-1}, organic matter 0.84 %, $CaCO_3$ 16.42%, (Nitrogen 0.05 % total) AB-DTPA extractable P 2.67 mg kg^{-1} and AB-DTPA-P and potassium as compared to the composite samples of 0-15 cm soil depth.

Soil Analysis Soil N content (0-15 cm depth)

Soil N application had significant ($P<0.01$) effect on the soil N content at 0-15 cm depth. The results indicated that significantly higher soil N content of O.080, 0.080 and 0.079% was recorded in plots receiving NPK at the rate of 60-30-20, 60-30-20-4 (Zn) and 60-30-20 kg $acre^{-1}$, respectively; followed by soil N

content of 0.077, 0.075, 0.075 and 0.072% determined in plots fertilized with NPK at the rates of 60-30-0, 60-40-20, 120-0-0 and 60-30-0 kg acre^{-1}, respectively. However, the lowest soil N content (0.036%) at surface level was recorded in plots received zero fertilizer (**Fig. 1**).

Soil N content (15- 30 cm depth)

Soil N application had significant (P<0.01) effect on the soil N content at 15-30 cm depth. The results indicated that significantly higher soil N content of 0.041 and 0.041% was recorded in plots given NPK at the rate of 60-30-0 and 60-30-20 kg ha^{-1}, respectively; while soil N at 15-30 cm depth was found relatively deteriorating to a level of 0.039, 0.039 and 0.039 % in plots fertilized with NPK at the rates of 60-30-20+4 (Zn), 60-30-20 and 60-0-0 kg acre^{-1}, respectively.

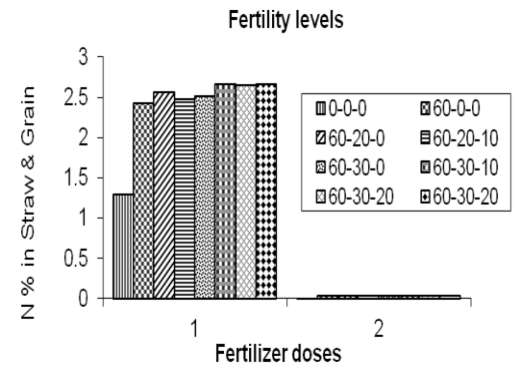

Fig. .1 Soil N content in mustard fields as affected by different fertility levels

However, the lowest soil N content (0.010%) at sub-surface level was recorded in control plots (Figure 1). It was noted that soil N content was remarkably affected by soil N along with P, K and Zn application in both the soil layers and soil received particularly N application had higher N contents than the control. The above results are fully supported by, (Blecharczyk *et al.,* 2014) and (Das *et al.,* 2003). Their consolidated experience indicated that the soil N after harvest was relatively higher at 0-15 cm depth as compared to 15-30 cm.

Plant Analysis Straw N content of Mustard

The N content in mustard straw generally associated with its soil application except certain levels of N that plants receives from air. The analysis of variance indicated that soil applied N-P-K was significantly (P<0.01) affecting straw nitrogen level in mustard crop. Straw N content was significantly higher (2.67%) in plants receiving NPK at the rate of 110-60-20 kg ha^{-1}, followed by straw N content of 2.64, 2.66, 2.51, 2.55, 2.48 and 2.43%, recorded in mustard plants fertilized with 60-30-20, 60-30-20-4 (2n), 60-30-0, 60-0-0, 60-30-20 and 60-30-0 kg NPK ha^{-1}, respectively. The lowest straw N content of 1.217 % was noted in control plants, where no fertilizer was applied **(Fig. 2).**

It was noted that with the soil application of N-P-K fertilizers, the straw N content was significantly improved, probably it happened mainly due to application of N, because there was a slight variation in straw N content in all the treatments when compared with control and among treated plants, the differences for straw N content were statistically non significant (P>0.05), but significant (P<0.01) when compared with control.

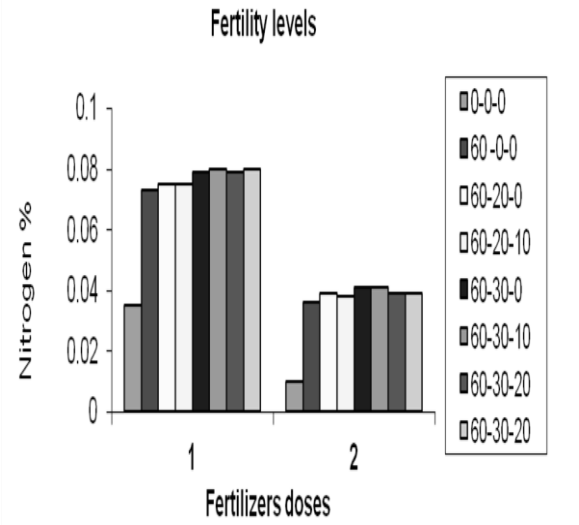

Fig. 2. Straw and Grain N content (%) in mustard as affected by different fertility levels

Grain N content of Mustard

The grain N content in mustard is also associated with soil N application except certain N levels received by the plants from air. The analysis of variance illustrated that soil applied N-P-K had significant (P<0.01) effect on grain N content of mustard crop. Grain N content was significantly higher i.e. 2.33, 2.29, 2.28, 2.27 and 2.27 % when plants received NPK at the rate of 60-30-0, 60-30-20-4 (Zn), 60-0-0, 60-30-20 and 60-30-10 kg ha^{-1}, respectively. The grain N content was slightly lower 2.23 and 2.17% when mustard plants were fertilized with NPK at the rates of 60-30-10 and 60-30-0 kg ha^{-1}, respectively. However, the minimum grain N content of 1.27% was noted in plants receiving zero fertilizers. It was noted that with the soil application of N-P-K fertilizer, the grain N content was significantly improved, probably it happened mainly due to application of N, because there was a slight variation in grain N content in all treatments and between treatments differences were non-significant (P>0.05), while the differences were highly significant for grain N content when compared with control (**Fig.2**).

The soil application of NPK fertilizer improved the straw and grain N content, probably it happened mainly due to application of N, because there was a slight variation in straw N content in all the treatments when compared with control and among treated plants, the differences for straw N content were statistically non-significant ($P>0.05$), but significant ($P<0.01$) when compared with control. The above results are partially supported by the findings of various researchers in different parts of the world such as (Tahir *et al.,* 2003), (Cheema *et al.,* 2001and Hedge and Babu, 2004). They concluded that NPK application increased the nutrient uptake (N, P & K) in the grain and straw of winter rye. Similarly, B. campestris was treated with NPK fertilizers gave higher yield and highest increase in N uptake (14.6%) and the highest ascorbic acid content (629 mg/kg fresh mass) were recorded for N applied as DAM 390 at 2 growth phases (80% N prior to sowing + 20% N during initial phase of head formation).

4. COCNCLUSION

Soil N was relatively higher in surface layer rather than sub-surface layer of the soil. The soil application of N has significant correlation to plant N analyzed. N application positive relation with N uptake and accumulation in the soil and plants. Fertilization variants were also had positive effect on the N accumulation in the soil and plant of the mustard. Further research work may be carried out to confirm these results.

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