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E-mail: bjsir07@gmail.com

Response of Different Level of Nitrogen and Phosphorus on Grain Yield, Oil Quality and Nutrient Uptake of Soybean

A. A. Jahangir, R. K. Mondal, K. Nada, M. A. M. Sarker, M. Moniruzzaman and M. K. Hossain.

BCSIR Laboratories, Dhaka. Dr.Qudrat-I-Khuda Road. Dhanmondi, Dhaka - 1205. Bangladesh.

Abstract

A field experiment was conducted to find out the effect to different levels of nitrogen and phosphorus on yield, oil contents and quality and nutrient uptake of soybean. The maximum plant height and number of pod per plant were recorded by the application of 40kg N / ha. Single application of phosphorus also bring significant increased in oil content of soybean. Nitrogen, phosphorus, potash content of soybean seed and straw varied with different treatment of NP. Interaction showed oil content of soybean was influenced with increasing level of nitrogen and phosphorus. The percent of oil and yield of soybean were found maximized by the application of 40kg N / ha + 30kg P_2O_5 / ha. However, moisture, density, refractive index and peroxide value of soybean oil remain more or less same throughout the experiment.

Key words : Nitrogen, Phosphorus, Oil quality, Nutrient content, Grain and Straw yield.

Introduction

Soybean is an important leguminous and oil seed crop. It accounts for approximately 50% of the total product of oil seed crop in the world. Soybean seeds contain about 40% protein and 20% oil which provide approximately 60% of the world supply of vegetable protein and 30% of the oil (Fehr. 1989). In our country soybean has been considered as a minor oil seed crop, its production and utilization is now increasing day by day (Alam and Chouwdhury1996). The production of soybean is low in our country. Imbalance use of fertilizer is one of the most important reason for low productivity. Nutrient interaction is one of the components of balanced nutrition. Soybean has a relatively high nitrogen requirement especially at later growing stages (Wantanabe *et al* 1983) and it has relatively higher phosphorus requirement which helps to stimulate root development (Patel *et al* 1992). Nitrogen and phosphorus are, however, considered necessary for grain yield of soybean (Galarao 1992). In view of the importance of soybean in vegetarian diet it is high time to attempt for best possible ways of investigation to improve the yield and quality of soybean. So the present investigation was carried out to study the effect of nitrogen and phosphorus on the yield, oil contents and quality and nutrient value of grain and straw of soybean.

Materials and Methods

The experiment was carried out in the Agronomy field of BCSIR, Dhaka during the winter season, 2004 with soybean (*Glycin max* L.cv.Shohag). The experiment was carried with three doses each of nitrogen and phosphorus with control treatment. The doses of nitrogen were 20(N_1), 30(N_2) and 40(N_3) kg/ha and those of P were 10(P_1), 20(P_2) and 30(P_3) kg/ha. The source of N and P were urea and triple super phosphate respectively. The unit plot sizes were 2.1m x 2.1 m. The row to row and plant to plant distance were 30cm x 30cm. respectively. The experiment was laid out in randomized block design with three replications. All the intercultural operations such as watering, weeding etc. were done as and when necessary. At the time of harvest, ten plants were selected at random from each unit plot. Yield components were recorded on the selected plants and for yield estimation the whole plot was harvested. The seeds collected from the field were cleaned and sun-dried. The seeds were then crushed in mortar. The oil was extracted in a soxhlet apparatus with light petroleum ether (40-60^O) for about 24 hours. The solvent was removed by rotary evaporator and the percentage of oil content was calculated. Specific gravity, refractive index and acid value were determined by IUPAC standard methods (1979). Nitrogen content was estimated by Kjeldahl method and phosphorus and sulphur sample analyses were digested with

*Corresponding Author, Email:jahangirbcsir@yahoo.com

$HClO_4$-HNO_3 acid mixture method of soil analysis (Page *et al* 1982).

The collected data were statistically analyzed following the Principles of analysis of variances and the differences among treatment means were adjusted by Duncan's New Multiple Range Test (Steel and Torrie 1960).

Table I. Physio-chemical properties of the soil in the experimental field.

Texture	pH	Organic matter(%)	Total nitrogen(%)	Available elements in soil.(µg/g)							
				N	P	Na	Ca	Mg	Cu	Zn	K
Sandy clay loam	7.2	1.5	0.04	79.3	0.45	20.3	135.2	242.9	4.08	7.5	21.3

Results and Discussion

Growth and yield character (Table II)

Plant height is an important character which influences the plot yield of soybean. The data presented in Table II showed the different levels of nitrogen had significant influence on plant height, number of pods per plant and plot yield of soybean. Nitrogen has been widely accepted as a dominant growth promoter. The significant increase of plant height was due to the vigorous root growth. Plant height was found to increase progressively with increasing rate of nitrogen fertilizer. The maximum plant height (56.70 cm) was obtained from the plot having fertilizer at the rate of 40kg N/ha. It was closely followed by 30kg N/ha. Approximately same number of primary branches and number of seeds per plant were obtained for different dose of nitrogen and phosphorus fertilizer. The highest number of pods (34.22) per plant was recorded in N_3 (40kg N / ha) treatment which were significantly different from the rest of the treatment. The next highest number of pod (32.28) per plant were noted from N_2 treatment. 100 seed weight ranged from 10.50g to 11.60g. Maximum seed yield (1701 kg / ha) per plot was obtained for application of higher doses (40 kg N/ha) of nitrogen fertilizer. The results are in close agreement with the findings of Saxena and Chandal (1992). The next higher plot yield of soybean (1630 kg / ha) was obtained from N_2 treatment (30kg N / ha).

Interaction of NP fertilizer on growth and yield character (Table III)

In case of interaction of N-P on the yield character was found to depend upon the plant height, number of pods per plant and seed weight are important. All the yield attributes increase with interaction nutrient management treatment expect the number of branches and number of seed per plant of soybean. The maximum number of pod per plant (37.10 cm) and yield per plot (1785 kg/ha) was produced from the plot receiving the nitrogen-phosphorus fertilizer at the rate of 40kg N/ha and 30 kg P_2O_5/ha. The results are in close agreement with those of Patel *et al* (1992) but the finding was par

Table II. Effect of different levels of nitrogen - phosphorus on growth and yield of soybean.

Fertilizer treatment	Plant height (cm)/plant	No.of branch/ plant	No of pods / plant	No of seeds / pod	100 seed wt (g)	Seed yield/ha (kg)
N_0 (0kgN/ha)	48.20 c	3.10 a	30.20 c	2.6 a	10.50 b	1400 d
N_1 (20kgN/ha)	54.15 ab	3.20 a	32.10 b	2.7 a	10.70 ab	1600 b
N_2 (30kgN/ha)	55.90 a	3.20 a	32.28 b	2.8 a	11.40 a	1630 b
N_3 (40kgN/ha)	56.70 a	3.30 a	34.22 a	2.7 a	11.60 a	1701 a
P_1 (10kgP_2O_5/ha)	55.86 a	3.20 a	31.41 bc	2.6 a	11.35 a	1600 b
P_2 (20kgP_2O_5/ha)	54.14 ab	3.20 a	31.61 bc	2.6 a	11.20 a	1500 c
P_3 (30kgP_2O_5/ha)	53.10 b	3.20 a	32.11 b	2.6 a	11.16 a	1600 b

Means with the same letter in a column are not different at 5% level of significance.

Table III. Interaction of different levels of nitrogen - phosphorus on growth and yield of soybean.

Fertilizer treatment	Plant height (cm)/plant	No.of branch/ plant	No of pods / plant	No of seeds / pod	100 seed wt (g)	Seed yield/ha (kg)
N_0P_0 (0kgN/ha + 0kg P_2O_5/ha)	48.10 d	3.1 a	32.10 c	2.6 a	10.60 b	1405 d
N_1P_1 (20kgN/ha + 10kg P_2O_5/ha)	55.90 c	3.2 a	34.17 b	2.7 a	11.00 b	1502 c
N_1P_2 (20kgN/ha + 20kg P_2O_5/ha)	53.90 c	3.2 a	34.30 b	2.5 a	11.25 ab	1500 c
N_1P_3 (20kgN/ha + 30kg P_2O_5/ha)	54.00 c	3.3 a	34.17 b	2.6 a	11.30 ab	1570 bc
N_2P_1 (30kgN/ha + 10kg P_2O_5/ha)	54.10 c	3.3 a	34.2 b	2.5 a	11.10 ab	1580 bc
N_2P_2 (30kgN/ha + 20kg P_2O_5/ha)	54.12 c	3.2 a	34.21 b	2.8 a	11.22 b	1617 b
N_2P_3 (30kgN/ha + 30kg P_2O_5/ha)	56.00 b	3.2 a	34.80 ab	2.6 a	11.40 a	1770 a
N_3P_1 (40kgN/ha + 10kg P_2O_5/ha)	56.05 b	3.3 a	36.20	2.4 a	11.63 a	1605 b
N_3P_2 (40kgN/ha + 20kg P_2O_5/ha)	56.70 b	3.3 a	36.10 a	2.5 a	12.00 a	1773 a
N_3P_3 (40kgN/ha + 30kg P_2O_5/ha)	58.90 a	3.2 a	37.10 a	2.6 a	12.11 a	1785 a

Means with the same letter in a column are not different at 5% level of significance.

tially disagreed with those of Bisht and Chandal (1996) who obtained the highest yield of soybean at the rate of 20kg N/ha + 40kg P_2O_5/ha.

Effect of NP fertilizer on NPK content of seed and straw (Table IV)

The effect of N - P fertilizer on nitrogen, phosphorous and potassium content of seeds and straws (Table IV). Results relating to various nutrient (NPK) contents as affected by the different dose of nitrogen- phosphorous fertilizer treatment. There was a significant effect of nitrogen-phosphorus fertilizer on nitrogen, phosphorus, potassium content of seed and straw than control treatment. The highest percentage of nitrogen in both the seeds (6.02) and the straws (1.78) were recorded from the plot receiving nitrogen fertilizer at the rate of 40kg/ha. The positive effect of nitrogen application on nitrogen content in seed of soybean have been reported by Singh *et al* (1997). Phosphorus level in seed varied from 0.58-0.59% and in straw it range from 0.21 - 0.22 % with N_2 treatment. The maximum phosphorus level in seed was 0.68% in P_3 treatment. Control treatment produced the lowest value for phosphorus content. The addition of phosphorous has favorable effect on uptake of soybean has been reported by Nimje and Seth (1988). The next value of phosphorous in seed (0.65 %) obtained from P_2 treatment. K concentration in seed was found to vary from 2.93-2.94% and 3.08-3.11% with nitrogen and phosphorus treatment respectively and its level in straw was 1.56-1.66% and 1.94-1.95% with P_2O_5 treatment respectively. The treatment of 30kg P_2O_5 k/ha showed the highest percentage of K (3.11) in seed only.

Interaction of NP fertilizer on NPK content of seed and straw (Table- V)

N concentration in seed was found to vary from 5.47 to 6.23% and its level in straw was 1.59 to 1.78%. The highest content (6.23 %) of N were found at N_2P_2 treatment. The next value of nitrogen content (6.21 %) in seed found from N_3P_3 treatment.

Table IV. Effect of nitrogen-phosphorus on nitrogen, phosphorus and potassium content (%) of seed and straw of soybean.

Fertilizer treatment	N content (%)		P content (%)		K content (%)	
Seed	Seed	Straw	Seed	Straw	Seed	Straw
N_0 (0kgN/ha)	5.46 b	1.38 b	0.39 b	0.19 b	2.66 c	1.54 c
N_1 (20kgN/ha)	5.68 ab	1.74 a	0.59 ab	0.22 ab	2.94 b	1.56 c
N_2 (30kgN/ha)	5.70 ab	1.75 a	0.59 ab	0.22 ab	2.94 b	1.65 b
N_3 (40kgN/ha)	6.02 a	1.78 a	0.58 ab	0.21 ab	2.93 b	1.66 b
P_1 (10kg P_2O_5/ha)	6.00 a	1.55 ab	0.64 a	0.30 a	3.08 ab	1.95 a
P_2 (20kg P_2O_5/ha)	5.67 ab	1.54 ab	0.65 a	0.31 a	3.08 ab	1.95 a
P_3 (30kg P_2O_5/ha)	6.01 a	1.75 a	0.68 a	0.31 a	3.11 a	1.94 a

Means with the same letter in a column are not different at 5% level of significance.

Table V. Interaction of nitrogen-phosphorus on nitrogen, phosphorus and potassium content (%) on seed and straw of soybean.

Fertilizer treatment	N content (%)		P content (%)		K content (%)	
	Seed	Straw	Seed	Straw	Seed	Straw
N_0P_0 (0kgN/ha + 0kg P_2O_5/ha)	5.46 b	1.38 b	0.40 b	0.19 b	2.66 c	1.54 c
N_1P_1 (20kgN/ha + 10kg P_2O_5/ha)	5.47 b	1.76 a	0.42 b	0.22 ab	2.97 b	1.55 c
N_1P_2 (20kgN/ha + 20kg P_2O_5/ha)	5.87 ab	1.77 a	0.42 b	0.22 ab	2.97 b	1.68 b
N_1P_3 (20kgN/ha + 30kg P_2O_5/ha)	5.89 ab	1.59 ab	0.53 ab	0.25 b	2.96 b	1.68 b
N_2P_1 (30kgN/ha + 10kg P_2O_5/ha)	6.20 a	1.59 ab	0.55 ab	0.25 b	3.06 ab	1.69 b
N_2P_2 (30kgN/ha + 20kg P_2O_5/ha)	6.23 a	1.60 ab	0.54 ab	0.32 a	3.17 a	1.99 b
N_2P_3 (30kgN/ha + 30kg P_2O_5/ha)	5.88 ab	1.76 a	0.68 a	0.31 a	3.07 ab	1.70 a
N_3P_1 (40kgN/ha + 10kg P_2O_5/ha)	5.87 ab	1.76 a	0.67 a	0.32 a	3.15 a	1.97 a
N_3P_2 (40kgN/ha + 20kg P_2O_5/ha)	6.19 a	1.77 a	0.67 a	0.33 a	3.15 a	1.97 a
N_3P_3 (40kgN/ha + 30kg P_2O_5/ha)	6.21 a	1.78 a	0.72 a	0.33 a	3.16 a	1.96 a

Means with the same letter in a column are not different at 5% level of significance.

The accumulation of P in seed of soybean were highest (0.72%) at N_3P_3 treatment. The next value of phosphorous (0.68 %) in seed followed by N_2P_3 treatment. The content of K in seed ranged from 2.97 to 3.17 % and that of in straw of soybean is from 1.55 to1.99 %. The nitrogen- phosphorous fertilizer at the rate of 30kg N/ha + 20kg P_2O_5/ha produced the highest concentration of K in seed (3.17 %) and in straw (1.99 %). Control treatment produced lowest percentage of K content of both seed and straw of soybean.

Effect on oil content quality (Table VI)

The percentage of oil content of soybean as affected by nitrogen-phosphorus fertilizer varied from 19.30 - 20.68 %. There was an increase in oil content with increasing doses of nitrogen. Higher doses of nitrogen produced higher percentage of oil of soybean. The results are in agreement with those of reported by Saxena and Chandal (1992) who observed that there was an increased trend of oil percentage in soybean by nitrogen fertilizer application. The oil percentage of soybean with phosphorus treatment varied from 19.20 to 20.65 %. In phosphorus treatment the higher value (20.65 %) obtain from P_3 treatment. The next value (19.68 %) was obtained from P_2 treatment. All the three treatments produced higher amount of oil than control treatment. Prasad *et al* (1991) reported that phosphorus application also improved the oil percentage of soybean.

Table VI. Effect of nitrogen-phosphorus fertilizer on oil content (%) and physiochemical characteristics of soybean oil.

Fertilizer treatment	Oil (%)	Moisture content (%)	Density at 28^{O}c	Refractive index at 28^{O}c	Peroxide value(me/kg)
N_0 (0kgN/ha)	18.30 b	8.08 a	0.91500 a	1.4652 a	1.73 a
N_1 (20kgN/ha)	19.30 ab	8.16 a	0.91492 a	1.4654 a	1.73 a
N_2 (30kgN/ha)	19.89 ab	8.17 a	0.91593 a	1.4650 a	1.74 a
N_3 (40kgN/ha)	20.68 a	8.08 a	0.91499 a	1.4649 a	1.72 a
P_1 (10kg P_2O_5)/ha)	19.20 ab	8.02 a	0.91480 a	1.4652 a	1.73 a
P_2 (20kg P_2O_5/ha)	19.68 ab	8.16 a	0.91501 a	1.4658 a	1.75 a
P_3 (30kg P_2O_5/ha)	20.65 a	8.15 a	0.91503 a	1.4648 a	1.74 a

Means with the same letter in a column are not different at 5% level of significance.

Table VII. Interaction of nitrogen-phosphorus on oil content (%) and physiochemical characteristics of soybean oil.

Fertilizer treatment	Oil (%)	Moisture content (%)	Density at 28^{O}c	Refractive index at 28^{O}c	Peroxide value(me/kg)
N_0P_0 (0kgN/ha + 0kg P_2O_5/ha)	18.30 b	8.10 a	0.91500 a	1.4655 a	1.73 a
N_1P_1 (20kgN/ha + 10kg P_2O_5/ha)	19.81 ab	8.09 a	0.91490 a	1.4654 a	1.72 a
N_1P_2 (20kgN/ha + 20kg P_2O_5/ha)	19.78 ab	8.08 a	0.91499 a	1.4652 a	1.72 a
N_1P_3 (20kgN/ha + 30kg P_2O_5/ha)	20.10 ab	8.11 a	0.91498 a	1.4651 a	1.74 a
N_2P_1 (30kgN/ha + 10kg P_2O_5/ha)	20.11 ab	8.12 a	0.91501 a	1.4650 a	1.73 a
N_2P_2 (30kgN/ha + 20kg P_2O_5/ha)	21.10 ab	8.10 a	0.91503 a	1.4690 a	1.72 a
N_2P_3 (30kgN/ha + 30kg P_2O_5/ha)	21.03 a	8.16 a	0.91500 a	1.4680 a	1.72 a
N_3P_1 (40kgN/ha + 10kg P_2O_5/ha)	20.14 b	8.10 a	0.91498 a	1.4665 a	1.72 a
N_3P_2 (40kgN/ha + 20kg P_2O_5/ha)	21.03 a	8.14 a	0.91501 a	1.4670 a	1.74 a
N_3P_3 (40kgN/ha + 30kg P_2O_5/ha)	21.14 a	8.11 a	0.91501 a	1.4649 a	1.73 a

Means with the same letter in a column are not different at 5% level of significance.

Interaction of NP fertilizer on oil content quality (Table VII)

In case of interaction of nitrogen phosphorus fertilizer on oil content varied from 19.81 - 21.14 %. The highest percent of oil was produced by N_3P_3 treatment (40kgN/ha + 30kg P_2O_5/ha). It was closely followed by N_2P_2 treatment (21.10 %). The change of moisture content, density, refractive index and peroxide value of soybean oil were insignificant during the growing period of soybean. The value of refractive index and density of oil ranged from 1.4649 to 1.4690 and 0.91490 to 0.91503 respectively.

Conclusion

The findings of the study indicate that nitrogen phosphorus fertilizer application improved the yield contributing character efficiency, leading to higher pod yield, oil content and nutrient content of soybean seed. So the further research is needed in this direction with other varieties of soybean to establish the present findings.

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